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A COMMEMORATIVE ISSUE.

The anniversary issue which we published last week celebrating the close of the first thirty years of existence of the ELECTRICAL WORLD AND ENGINEER and the beginning of its fourth decade, has been received in a most cordial and appreciative manner by our friends and readers, many of whom have been good enough to address us letters of congratulation upon the event and wishing us God-speed for the future. In doing so, several of them have expressed surprise at the size of the number, as well as at the variety of the contents and the quantity of advertising. These remarks and felicitations encourage us to make one or two notes as to the difference between the earliest issues of this journal and that of March 5. A comparison might be made with the old *Operator*, even more emphatic as to the growth of the journal, but it will suffice to give a few figures as to the first issue of January, 1883—when the paper became the *Operator and Electrical World*—and the last one just published.

Twenty-one years ago this journal, therefore, gratifying its worthy ambitions and rising from the status of a paper merely for operators to that of one covering the entire electrical field, although it had previously given a great deal of space to general electrical topics, was proud to call attention to the fact that it consisted of no fewer than 16 pages. Eight of these pages were devoted to text and eight to advertisements. As the form was then that of a folio, these pages were nearly twice the size of the present quarto, making, therefore, roughly, about 16 pages of text and 16 pages of advertisements. Last week the ELECTRICAL WORLD AND ENGINEER published 90 pages of text with a four-page supplement, and 196 pages of advertisements. In the first issue of January, 1883, the 16 pages of advertising contained 66 advertisements, including one or two of the publisher with regard to books. The last issue contained no fewer than 593 advertisements. The contrast between two such issues is indeed remarkable, but is only in keeping with the wonderful growth and expansion of the electrical arts in general.

THE DEVELOPMENT OF INDUSTRIAL ELECTROCHEMISTRY.

In the swift advancement of all branches of electrical engineering during the thirty years of the life of this journal, elecrochemical industries have vigorously participated only during the latter half of this period. It may perhaps not be surprising to read in Dr. Roeber's article published in our last issue that thirty years ago commercial electrochemistry was represented only by some branches of electroplating and by primary battery engineering; yet it is probably not generally known that the first American electrolytic copper refining plant was erected so recently as in 1882 while now 85 per cent. of all the pure copper of the world is electrolytically refined in this country. Most of the other electrochemical processes are of still more recent date. The electrical engineer has become intimately connected with electrochemical engineering by the introduction of the storage battery into central stations and sub-stations; he has there learned that electrochemical methods are the most suitable ones for storing electrical energy. But this storage of large amounts of energy is a feature also characteristic of the industries which represent the reverse problem of battery engineering, namely the production of chemical effects by electrical means.

A cursory review of these industries shows an astonishing variety of methods available for producing a certain chemical effect. We

have electrothermic reactions in the electric furnace, electrolytic reactions, combinations of electrothermic and electrolytic reactions, and the methods of discharges through gases. To take a single case, to get caustic soda and bleaching powder from common salt, we have three essentially different classes of electrolysis of an aqueous solution of sodium chloride—the mercury cathode, diaphragm, and gravity processes—besides the electrolysis of fused salt with a lead cathode. All these processes are worked on a commercial scale and the classes of mercury cathode and diaphragm processes alone cover quite a number of essentially different methods. All these different processes, however, are characterized by one common feature, namely, that care is taken to keep the anodic and cathodic products of electrolysis separate from each other. That this is possible in so many different ways, characterizes the variety of electrochemical methods. On the other hand, if we provide means which facilitate the reaction between the anodic and cathodic products in the electrolysis of sodium chloride, we get hypochlorites or bleaching liquor. This shows how by an apparently slight modification of the process we get other products.

The effect of varying the result by changing the condition of the same experiment is perhaps most beautifully illustrated by the simple reaction between silica and carbon in the electric furnace, which may yield either carborundum or "white stuff" or silicon or graphite or silixicon. But while this example illustrates the enormous possibilities of electrochemical methods it also illustrates the inherent difficulties of electrochemical engineering, since it shows the necessity of carefully establishing and maintaining the proper conditions of operation in every process. The abundance in this country of valuable raw materials, and especially metals, to which electrochemical methods can be advantageously applied, coupled with the fact that our electrochemical and electrometallurgical engineers, every one of whom is a pioneer in a new field, are not working by the rule of thumb but according to exact principles, appears to fully justify the very high hopes entertained by those most competent to judge for the future of industrial electrochemistry. Here we believe will be a large part of the valuable work to be done during the next thirty years of this journal.

THIRTY YEARS PROGRESS IN ELECTROMAGNETIC THEORY.

It is very interesting to consider the growth and development of electric theory during the past three decades. It has not been so much in the physical or pure theory as in the applied theory that the advance has been made. In the fundamental theory of the science, as reflected in the works of Gauss, Weber and Maxwell, thirty years ago, there is comparatively little increase; but in electrotechnical theory there has been a great advance and development. For example, the theory of the magnetic circuit has been developed during the last thirty years, and without this theory very little practical development could have been made in the art of constructing dynamos. All advances in construction would have been by empirical groping. Thirty years ago there was no alternating-current technology worth mentioning. Our recent industrial development of power transmission has rendered necessary an applied science of alternating-currents which is already extensive, and is constantly extending.

In the direction of electromagnetic waves, science has made notable advances in three decades. In that time the proposition has been set up and established that radiant energy is of electromagnetic nature, viz.: an oscillatory electromagnetic disturbance in the ether. Waves of radiant energy have been artificially produced by electric means with wave lengths as small as a few inches; but no artificial electric mechanism has yet been devised to produce wave lengths as short as a few microns, the condition necessary in order that the retina may respond, and the stimulus of light be produced. Of recent years the electronic theory has made great strides as a working hypothesis. It is still only in the stage of partial development. It is very comprehensive in its scope, since it may be said to offer an explanation of all matter, on the basis of electrical point sources in the ether. It also attempts to explain the phenomena of mechanical inertia, or the vis-inertia of matter, on the basis of self-induction in moving electrons; i. e., the moving charges that by postulation form matter. According to this theory, all electric charges are associated with ions or portions of atoms. No communication of electric charge can occur without the movement of such ions. Electric waves in free ether are, however, capable of carrying away the energy of such ions. All this theory has been created during less than thirty years, and if not yet demonstrated it must at least be admitted that each succeeding year gives more support to the theory.

Concerning the fundamental nature of electricity itself, there is still no certainty, but there are several hypotheses. There are several theories for explaining both electricity and magnetism in terms of the ether. None of these theories seem capable of being submitted to experimental demonstration. It is certain, however, that, since the interconnection between electricity and magnetism is known, a demonstration of the nature of the one must, by corollary, include a disclosure of the nature of the other. Moreover, it would now seem likely that the complete unraveling of the nature of electricity would necessarily include a revelation of the nature both of matter and of gravitation. All that can be said with reasonable certainty at present seems to be that electricity and magnetism are states of disturbance in the universal ether, although the exact kind of disturbance cannot yet be defined, partly because the mechanism of the ether itself must be sufficiently known in order to differentiate its disturbed conditions from its normal conditions. In the case of air, as an atmosphere on the surface of our globe, we have a sufficiently clear idea of its nature to enable us to say that a streaming disturbance of the air, necessarily accompanied by spinning or vorticity, constitutes the phenomenon that we all recognize as wind. Wind may, therefore, be defined as a particular disturbance of the air. Sound, as it reaches our ears, we attribute to a different kind of disturbance in air. So it seems clear, in like manner, that magnetism and electricity are particular disturbances in the ether. Just what the disturbances are is not clear. But we know that the two disturbances are mutually related in the manner that streaming is related to spin or vorticity in an incompressible fluid. Consequently, as the material for producing wind is always present, if we have suitable mechanism, say a fan, and power to drive it; so the material for producing electricity or magnetism is always present in the universal ether, if we have suitable mechanism, say a dynamo, and power to drive it.

PREDETERMINATION OF TRANSFORMER REGULATION.

The alternating-current transformer is a most useful and a marvelously simple machine for exchanging volts into amperes, when the terms of the statement are treated broadly, and not read through technically-adjusted spectacles. The transformer, however, has one objection, namely, that no practical plan of compounding it has yet been found. As the load comes on a so-called "constant-potential transformer," it forgets, to some extent, its duties to constant potential, in paying attention to the load. The pressure at terminals drops under load, like that of a shunt dynamo. The drop is small in large, well-constructed transformers, on non-inductive loads; but it is quite appreciable on inductive load, and, moreover, there is also the inevitable drop in secondary wiring. The result is that an automatically compounded transformer to maintain constant pressure under all loads at the mean distance lamp would be a great boon. Something might be done by suspending the secondary coil, and allowing it to approach the primary coil under load, as in the "tub-system"; but this would destroy the beautiful simplicity of the transformer mech-

anism. It is known that a constant-potential transformer, in addition to its pressure-varying properties, behaves like a single choking coil in the primary circuit. This proposition has been published in our columns. It is known that the resistance of the equivalent choking coil is the total resistance of the coils of the transformer, when reduced to a level transformer. It is also known that the inductance and reactance of the equivalent choking coil can be obtained from measurements made with short-circuited secondary.

In an article appearing on page 515 of this issue, Mr. E. G. Reed gives an empirical formula by which the inductance of the equivalent choking coil can be computed for a transformer of a particular type of construction. The formula involves the square of the number of primary turns and some geometrical relations that may be taken from the working drawings. This is a very convenient formula, and is given in one of the text-books on the subject. Mr. Reed gives a table of numerical data for a series of commercial core-type transformers, setting forth the inductances as computed in the above manner. The results are said to correspond very closely with the experimentally observed values. It appears from Mr. Reed's interesting table that the reactance factor of this line of transformers increases from 0.5 in 0.5-kw size, to 3.64 in 50-kw size. Also that above 10 kw the reactance factor very nearly follows a straight-line law, with respect to size of transformer, increasing 0.5 for every 10 kw. The reactance factor of this line of transformers, according to the table, may, in fact, be expressed, for sizes above 10 kw, by the equation $f = 1 + P/20$, where f is the reactance factor and P the capacity of the transformer in kilowatts. It is evident from an inspection of the values given in the table that the percentage resistance drop diminishes nearly according to a straight-line law beyond 20-kw capacity, being then expressed, approximately, by the equation, $n = 1.6 - 0.011\ (P - 20)$. On the other hand, the reactance drop steadily increases with the capacity. This would mean that such transformers would regulate better in increasing sizes on non-inductive loads, but would not regulate better, and even somewhat worse, in increasing sizes, on heavily inductive loads.

HIGH-TENSION CONSTRUCTION.

Mr. Semenza's paper on this topic at the last Institute meeting is a most instructive presentation of the results following from European conditions. In almost every department of engineering the differing conditions here and abroad affect current practice deeply, and line construction is no exception to the rule. As the author very truly remarks, the importance of good line construction was slow to be recognized and insufficient precaution were taken against trouble. A few years served to teach the lesson of thoroughness, and line work as now carried out both here and abroad is reduced to a matter of careful and thorough engineering. But conditions vary from country to country and the practice advocated by Mr. Semenza would, we fear, generally lead to difficulties here. In the first place, they seem to have a curious fashion of figuring rights of way in Mr. Semenza's country, at so much per pole. Here it is generally regarded as very bad practice to secure anything less than a full right of way for complete access to the line at all times, and on important systems the right of way amounts to a considerable acreage. Preferably, we take to highways through our less settled and more heavily wooded country as the only way of securing proper access to the line without prohibitive expense. In either case, a full private right of way or utilization of a public way, there is nothing of any material account to be saved by increasing the span so far as cost of way is concerned. Then we are, of course, compelled here to face climatic difficulties to an extent unknown in Italy. Our extremes of temperature and the dangers from snow, sleet and wind are so serious that a factor of safety which would be permissible in a milder climate is quite out of the question here. This alone would account for many of the differences in line construction.

The ordinary American preference for rather thick wooden poles and rather short spans is mainly due to fear of the strength of long spans in our rather ferocious climate. We are just beginning to use long spans and steel towers, an extension of Mr. Semenza's methods, and their success here is still very problematical. Again, we are apparently able to get a far better wooden pole here than in Italy, for the life quoted by Mr. Semenza for wooden poles of two to ten years is far shorter than is found in American practice. In fact, ten years would be about the minimum life for wooden poles such as are used on the best American transmission lines, and it is an open question whether steel lattice poles would not be dangerously weakened by rust in a time not very much longer when exposed to a really bad sample of American climate. Again, on our long high-voltage lines running through a sparsely settled country, the insulating properties of wooden poles and cross arms are a valuable asset. Every manager of a transmission system can call to mind cases where an insulator has broken without serious results, the wire falling upon the cross arm harmlessly or with only inconsiderable burning, and staying in this position until repaired. A similar accident with a steel supporting structure would quite certainly put the line out of commission for some hours. Of course, in this connection the cross arm is more important than the pole, and steel poles, if they ever come into considerable use here, will quite certainly be used with wooden cross arms very thoroughly treated. In short, it seems very doubtful whether steel poles can be used under American conditions with any such advantage as is claimed for them by Mr. Semenza in Italian practice.

It would be very interesting to know the relative properties of American and European insulators. Here glass is used on some very high-tension lines with capital results, but as Mr. Semenza indicates, it is a material under suspicion as to durability. The cheaper labor abroad and the experience of many years in porcelain manufacture certainly should make it possible to obtain high-grade insulators far more cheaply there than here. On our great transmission systems the steady upward tendency of voltages keeps the insulator maker constantly upon the jump. No sooner does he standardize a good insulator for 30,000 volts than a call comes for an insulator to stand 50,000 or 60,000 volts. The present tendency in design of insulators is bad so far as successful production is concerned. Too much stress has been laid on dimensions in the mistaken notion that two square feet of bad insulating surface is better than one square foot of first-class material, and the result has been huge insulators of dimensions which make proper mixing and firing of the clay extremely difficult, and add new difficulties to line construction. Of the voltages now in use wide separation of the line is imperative and even at moderate voltages wide separation is advisable to lessen the chance of interruptions of service by wind-blown branches or by birds fouling the wires, and the weight of these big insulators becomes a rather serious matter. We like the insulator designs shown by Mr. Semenza. They seem well fitted to prevent surface leakage, and neither present undue surface to creeping discharges nor needless weight to render proper support difficult. The foreign practice, too, of cementing in the pins seems better than our common method of screwing them in, although in this connection it is of course not unusual to cement in pins here. In the electrical design of the lines Mr. Semenza follows much the same practice that is current here, although on most of our lines regulation is the controlling factor in the choice of line loss. As a practical problem, figuring the theoretical best cost of copper is a very troublesome proposition here on account of the very uncertain selling price of the energy transmitted.

Developments in the Allis-Chalmers Situation.

The recent announcements in these columns with regard to the intention of the Allis-Chalmers Company to enter the field of heavy electrical machinery, as well as to develop the production of steam turbines, hydraulic turbines, gas engines, etc., in addition to its other well-known and standard lines of prime-movers, has been noted with the greatest interest by every one throughout the country occupied in electric light, power and traction. It would appear, however, that the Allis-Chalmers management is by no means at the end of the radical and decisive moves which it is to make under the new régime just entered upon, for as we go to press other developments are announced or rumored.

One of the most important events within the past few days has been the conclusion of an alliance between the Allis-Chalmers Company and the Bullock Electric Manufacturing Company. Some time ago the Bullock Company secured a heavy contract for the equipment of the new Allis-Chalmers shops in the vicinity of Milwaukee, an event which may possibly have led up to the present deal owing to the satisfactory results obtained with the apparatus under test. Be this as it may, it now appears that the Bullock Electric Manufacturing Company, of Cincinnati, which is a New Jersey corporation, has been leased by a new Bullock Company organized under the laws of Ohio. This new corporation is one in which the Allis-Chalmers Company is financially interested as principal owner, and it takes over the business of its predecessor as a going concern. In this manner the Allis-Chalmers Company is at once able to fill orders ranging throughout the entire field of direct-current and alternating-current generating apparatus, Mr. B. A. Behrend, the engineer of the company, having added to the well-known standard line of direct-current motors and generators, rotary converters and some of the largest types of polyphase alternators and synchronous motors complying with the most exacting requirements in this country. It is also understood that the Bullock output now includes street railway motors, and that some of these have already been supplied to a road in Indiana. In this connection it is interesting to record that the new company has made a personal contract with President George Bullock, under whom the old company was vigorously and successfully built up, so that the administration of the company will remain unchanged, a contract having also been made with Mr. Neave for the retention of his services as vice-president. Some curiosity has been expressed in electrical circles as to the manner in which the Allis-Chalmers Company would be able to come at once into the market with electrical apparatus, instead of waiting one or two years to develop productions of its own, but it will be seen that this move provides for it a very satisfactory solution of the problem, enabling it to bid at once on whatever contract may be offered.

In connection with the affairs of the Allis-Chalmers Company, itself, and its own internal management, it would appear that some vital and important changes are being made. The first and most noteworthy of these is the resignation of President Chas. Allis, whose wife has been in seriously ill health and is now proceeding to the Mediterranean under medical advice for an indefinite stay. Mr. Allis felt that under these private conditions he could not possibly give all the attention to the business of the company that its affairs demanded at this juncture, and preferred, therefore, to take this step. His place in the management is to be filled by Mr. B. H. Warren, formerly vice-president of the Westinghouse Electric & Manufacturing Company and a man of distinguished engineering and business attainments, as well as of marked energy and executive ability. It is also understood that Mr. Edward D. Adams, the banker, who has been identified with the company since its organization a few years ago, has consented to take the chairmanship of the executive committee, this step involving the abolition of some of the previously existing committees and the concentration of a great deal of responsibility and power in his hands. Mr. Adams will, in fact, make his offices at the New York headquarters in the Empire Building and give a large amount of his time and thought to Allis-Chalmers affairs. No more striking proof could be given of the vigor with which the business of the company is to be pushed than these two events.

It has already been stated in these columns that Mr. John F. Kelly, formerly of the Stanley Company, has been made head of the electrical engineering department of the company, with Mr. William Stanley, Jr., as consulting electrical engineer; and to this may now be added the fact that Mr. Kelly has already begun his work and taken up affairs at the Allis-Chalmers offices. The company has other important plans and arrangements under contemplation, but the announcement of these above will suffice to keep the eyes of the electrical community fixed upon the action of the newcomer, whose entrance into the field must obviously be most profoundly felt.

In connection with Bullock Company affairs, we quote Mr. Joseph S. Neave, vice-president of the corporation, as follows: "The present Bullock Electric Manufacturing Company will remain intact. The same officers will be continued, and also the same management. The old company is incorporated according to the laws of New Jersey. There will be another Bullock Electric Manufacturing Company formed according to the laws of Ohio. This will be the leasing company of the plant, and this company will run the Bullock plant as it is run at the present time. In fact, the Bullock Electric Electric Manufacturing Company and the Allis-Chalmers plants will be run as if they were one concern. The Allis-Chalmers Company guarantees to pay the 6 per cent. dividend on the preferred stock of the Bullock Company. It goes further; the Allis-Chalmers Company agrees to pay 6 per cent. on the common stock of the old Bullock Electric Manufacturing Company for all the assets of the Bullock Electric Company that are over and above the valuation of the preferred stock.

"As an explanation of the payment of dividends for the common on the quick assets of the company, it might be stated that the preferred stock of the present Bullock Company amounts to $1,100,000, and the common to $1,000,000. Thus, after the valuation of the plant has covered the preferred stock and there should be, for instance, $500,000 of what is termed quick assets over, the Allis-Chalmers Company guarantees, during the life of the lease, 6 per cent. on this amount for the Bullock common stock.

"Besides the payment of these dividends," continued Mr. Neave, "the Allis-Chalmers Company agrees to divide the profits of the concern between the new company and the common stock of the old company. This will tend to make the earning power of the common stock of the old company a great deal more than it is at the present time.

"As a result of this deal with the Allis-Chalmers Company, the present capacity of the Bullock electrical works is to be enlarged. The first thing that will be done will be to erect another large shop, with an area of 40,000 sq. ft., where motors for street cars will be manufactured. This will mean the employment of about 400 more hands. It is the intention of the new leasing company to enter actively into the street car equipment field. The lease is for 25 years with the privilege of renewal for another 25 years on the same terms. It is my opinion that when the plants that are now under way have been completed the Bullock electrical works will give employment to from 2,000 to 3,000 hands.

"While the papers in the deal have all been signed, the deal will not go legally into effect until after the stockholders of the present Bullock Electric Company have had their special meeting at Jersey City on Wednesday, March 16. Mr. George Bullock and myself will be at that meeting with the proxies to ratify the deal."

Telegraph Between Irkutsk and Pekin.

The Commercial Cable Company is advised that by an arrangement with the Great Northern Telegraph Company, the direct wire between Irkutsk, Siberia, and Pekin, China, is open for the interchange of business.

Trolley Beats Steam.

A special dispatch to the daily press from Kansas City, Mo., of March 4, says: "In a two-and-a-half-mile race between a Missouri Pacific express train and an electric car on the Leavenworth-Kansas City line last night, the railroad locomotive was beaten by two car lengths. The roads are parallel, and the electric line manager waited with a party of road officials at the beginning of the stretch. The railway engineer put on all steam, and the cars ran even until the last quarter of a mile, when the electric car slowly forged ahead, and bounded across the finish line at fifty miles an hour, winner by 120 feet." We do not see that this proves anything in particular, or of any value, although it may be a good "ad" for the local trolley service.

The Electric Power and Transmission System of Schaffhausen, Switzerland.—I.

ONE of the most remarkable of Switzerland's hydro-electric plants is that located at the famous Schaffhausen Falls on the headwaters of the Rhine in northern Switzerland. As early as 1863 Heinrich Moser built a water power plant for the municipality of Schaffhausen. In this plant three turbines aggregating 700 hp were installed, and power was delivered to Schaffhausen, three miles distant by wire-rope transmission, the ropes running over sheaves supported on piers erected several hundred feet apart. In 1887 a second power house was erected below the first one and five 300-hp turbines were installed.

In 1891 the Oerlikon Company furnished the Schaffhausen Insane Asylum with a lighting dynamo arranged to be driven by a branch of the rope system. A citizens' committee was formed at the same time to decide whether the old system should be repaired and retained or electric transmission installed. After extended study the municipality closed a contract with the Oerlikon Company, in 1896, for a complete electric generating and transmission system. This order called for two 2,000-volt alternators connected by bevel gearing to two 300-hp turbines rented by the municipality from the Schaffhausen Water Works Company. Current from these generators is transmitted by buried cables to the several transformers in the town. Outside the town limits wires carrying secondary voltages only are strung on wooden poles.

By December 31, 1897, current was being furnished to 26 hp in motors and for arc and incandescent lamps equivalent to 86,940 cp. The electrical machinery cost $23,493.94 (121,730.24 francs). During the first year power was produced at the cost of 11.14 cents per kw-hour. In 1898 the municipality of Schaffhausen purchased for $123,520 (640,000 francs) the two power plants and dam owned by the Schaffhausen Water Works Company and immediately set about to install a completely electrified system. The following changes were to be made by the Oerlikon Company: Replacing the three old turbines in the upper station by new ones suitable for direct connection to generators, and adding another turbine and generator to the lower station, making in all for that station five turbines, including three turbo-generator sets, one of the latter being a reserve unit.

The rebuilding of the upper station was begun in March, 1900. Before the old structure was torn down the machinery was temporarily enclosed in a wooden building erected inside of the old one. The new station is of steel skeleton construction and has a roof made of wood and cement. The new turbines and alternators were placed in service in January, 1901. During the same year two Oerlikon rotary converters for the Neuhausen-Schaffhausen Street Railway were also placed in this station.

The new equipment has given such satisfaction that the municipality is seriously considering the replacement of the old turbines in the lower station by new ones, and later purchasing and modernizing the remaining power plant of the Schaffhausen Water Works Company.

This station is 460 ft. below the upper one and is connected to the right shore of the Rhine by an iron bridge, which is also used to carry the high-tension cables. The pit is built of concrete, and the rest of the building of brick. In the western part of the machinery room a wire partition encloses the power unit leased by the Schaffhausen Worsted Works.

The water flow to the five turbines is regulated through iron double-turning doors from the floor of the machinery room. The northern half of the eastern part of the machine room is served by a six-ton crane, and the southern half by a five-ton crane. Five 14-amp. arc lamps and forty 25-cp incandescent lamps are used to light the station.

The power equipment of the Schaffhausen Worsted Works consists of two Jonval turbines built by J. J. Rieter, two Oerlikon dynamos and Oerlikon controlling apparatus.

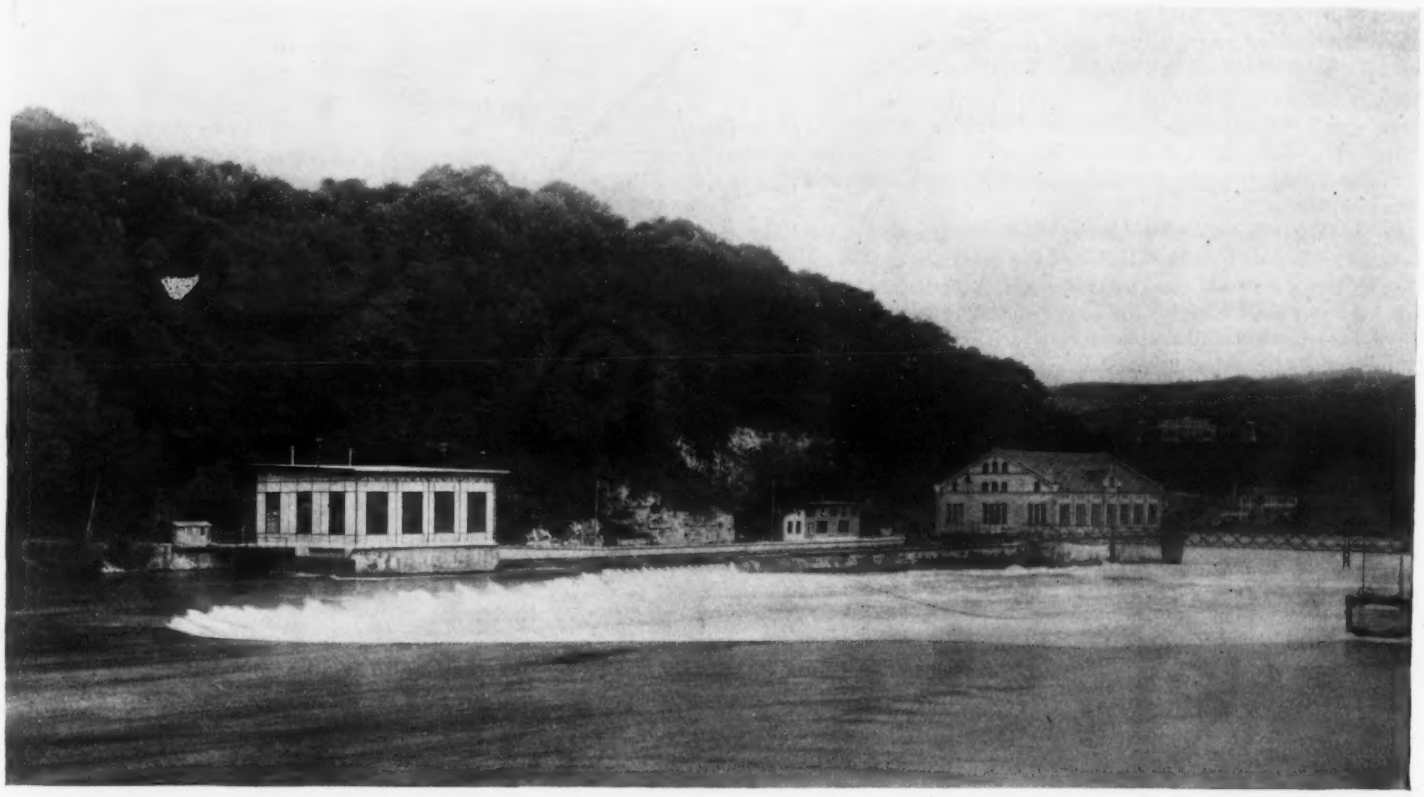


FIG. 1.—GENERAL VIEW OF BOTH POWER HOUSES ON THE RHINE AT SCHAFFHAUSEN.

With a fall varying from 14 ft. to 16 ft. and 2,000 to 2,250 gallons, the turbines give 350 hp at 60 r.p.m. The turbines are fitted with two concentric wheels, both being used at high water and the outside one only at low water periods. When both wheels are used the hand cover on the inner one is removed. The outside diameter of the turbine is 11 ft., the inner diameter 6 ft. (1.79 m.). The leading wheels, which carry a forged-iron suction casing at the lower end, have each 40 cast-iron vanes 1½ in. thick. The running wheels, the lower parts of which are 1.4 above lowest water, have each 42 vanes ½ in. thick.

Power is transmitted from the turbines to the dynamos by bevel gearing and rope shafts, which are 13 ft. in diameter, and have 10 grooves for carrying the rope drive, consisting of hemp ropes, each 2 in. in diameter.

The two Oerlikon direct-current generators used were built in 1890; they have six poles and a capacity each of 300 hp, 700 to 750 volts, at 200 r.p.m.

The controlling apparatus for these machines is mounted on an iron-supported switchboard having a marble front, the other sides being covered with perforated tin. There is one double-pole switch,

one ammeter and one voltmeter for each machine. The outgoing cables can be cut out through two double-pole switches. During lightning storms the current is cut off and the overhead cables are grounded through another double-pole switch. Two shunt regulators and two primary current resistances are used in starting the dynamos. The four outgoing cables are protected by four lightning arresters, and are divided into two pairs, each of which is connected in parallel.

The eastern part of the machine room contains the three hydro-electric sets, two of which generate single-phase current and the third or reserve unit either single-phase or polyphase current. The turbines are of Jonval type and were built by Escher, Wyss & Co., of Zurich. The two turbines for running the single-phase machines have vertical shafts and are built for a head of 15 ft. and a flow of 1,700 second-gallons. Their speed is 48 r.p.m.

At high water the head decreases to 11 ft., and it is, therefore, necessary to increase the flow to 2,250 second-gallons to get the required power. This is accomplished by using two concentric wheels having respectively 36 and 24 vanes. The outside wheel only is used during low-water periods, but both wheels are required at high water. It may be mentioned in this connection that these turbines were not originally intended for electric service.

Power is transmitted from the vertical shafts by horizontal intermediate shafting and head gearing, as it was found inadvisable to couple the turbine and generators on the same shaft, owing to the low peripheral speed of the turbines and the limited space between them.

The 300-hp, single-phase alternators are of the inductor type and at 167 r.p.m. generate 100 amp. at 2,000 volts and 50 cycles. The efficiency of these machines is 92 per cent. at full load and 87 per cent. at half load.

The inductor has no wire windings, but carries 2 x 18 pole shoes made of an alloy of tin and iron. These poles are arranged in pairs lying in the same axis for generating the induction in the armature windings and thus forming the required magnetic yoke.

The inductor has a diameter of 8.75 ft. and revolves inside the armature housing, the inside diameter of which is 8.7 ft. In the armature housing 2 x 36 armature spools are set in grooves. These spools are thoroughly insulated and consist of seven windings made of copper strips 25 mm. broad and 1.4 mm. thick. The spools of both armature halves are connected in series and are wound in the same direction. The armature housing can be so manipulated as to permit the ready inspection or substitution of all armature parts. The exciter spool is mounted between the two armature halves. It consists of a massive casing containing 305 windings of copper wire 7 mm. thick.

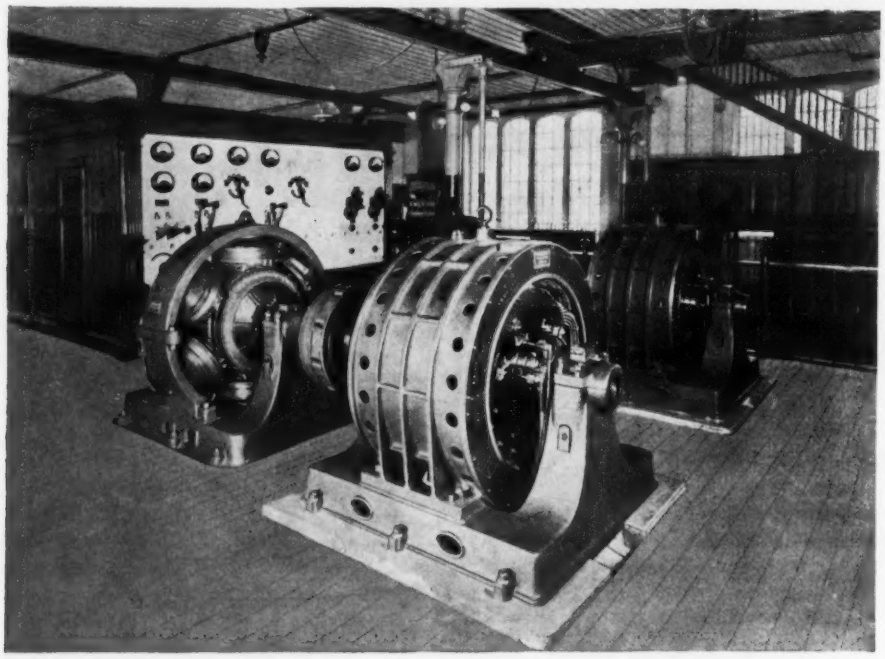


FIG. 2.—VIEW OF INTERIOR OF LOWER POWER STATION, SCHAFFHAUSEN.

The base plate of each exciter is cast solid, with the corresponding alternator. The exciters are all of double-pole type, giving at 420 r.p.m. 120 amp. at 50 volts. Each is driven by four ropes, each 15 mm. in diameter from a rope sheave mounted on the shaft of the corresponding generator. If necessary, one of these machines can be used to excite two alternators. The voltage of the alternators is regulated in the excited circuits.

The third generator has a rated capacity of 350 hp and is built for single-phase and polyphase work. As a single-phase machine it gives at 167 r.p.m. 210 kilovolt-amperes at 2,000 volts, and as a polyphase alternator 300 kilovolt-amperes at same speed and voltage. The frequency in each case is 50 cycles. The general arrangements of this machine are similar to those of the other two just mentioned, with which it must be operated in parallel. The armature is divided into two parts connected in series, each part having 108 grooves and 54 spools. Each spool is made up of 18 windings, each winding consisting of two parallel wires 3/16 in. in diameter. The exciter spool consists of 300 windings of insulated copper strips measuring 1 x 60 mm. The insulation between each winding is composed of asbestos bands about 1/64 in. thick.

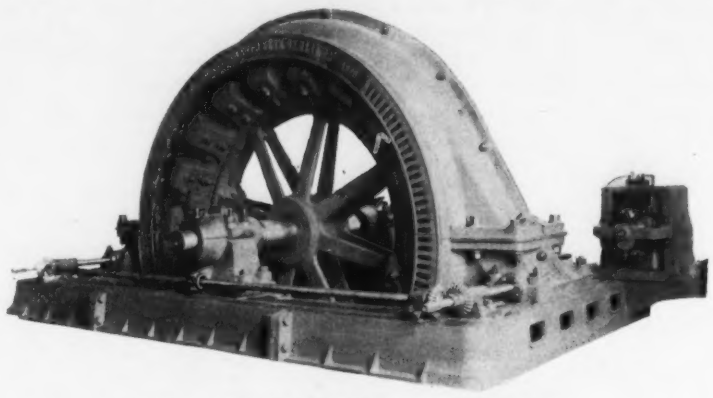


FIG. 3.—300-HP SINGLE-PHASE ALTERNATOR.

The inductor and armature housing are like those of the 300-hp machines described. The exciter is also the same as the others. The armature has 54 grooves, each of which serves to take four leads, each consisting of four parallel wires of 2.2 to 2.8 mm. diameter. The two parallel-connected magnet spools consist of 1,200 windings of wire measuring 1.6 mm. to 2 mm. in diameter.

All of the controlling apparatus is enclosed in several wooden housings, with marble fronts. These several housings and boards were built at different times as the station developed. Owing to the number of machines to be looked after, the designers concluded that they could be better handled if controlled from separate and nearby switchboards rather than from a central and more distant board.

The single-phase switchboard includes also instruments for the third generator when used for single-phase. The board is divided into seven panels. Each of these panels contains the following instruments for each generator: Ammeter, voltmeter, hand switch, lever, double-pole switch, phase lamp for paralleling the generators, hand wheel for regulating, and carbon-contact circuit-breaker. The two regular single-phase machines can be regulated simultaneously by a Gall's chain. The fourth panel carries an ammeter for measuring all the single-phase current, a constant voltmeter with optical and acoustic signals, voltmeter switch and two double-pole switches for paralleling two alternators.

There is a separate panel for each exciter furnished with ammeter, voltmeter, hand lever for double-pole switch and for carbon-contact circuit-breaker, as well as hand wheel for shunt regulation. The board is also furnished with a large voltmeter, which indicates the voltage on the city lighting lines, and thus enables the station attendant to keep the voltage at the proper point. The housing also contains a number of other controlling devices.

The second switchboard serves as a center for the control of the third generator when used for polyphase working, and also for the polyphase current transmitted from the upper works. This board consists of four panels. The one for the reserve generator carries a voltmeter, ammeter, regulating wheel and levers for three-pole

switch and carbon-contact circuit-breaker. The next panel controls the polyphase current from the upper station and carries a voltmeter, ammeter and lever of three-pole switch. The other panels carry instruments for measuring all the current in circuit. Other controlling apparatus is mounted inside the switchboard housing.

The southeast portion of the station contains two motor-generator sets for railroad service. One of these sets is always held in reserve. The motors receive current either from the upper station or from the reserve generator in the lower station.

The twelve-pole polyphase motors of these sets are built for 150 hp at 490 r.p.m., using 2,000 volts at 50 p.p.s. The stator has 144 slots, each of which receives 8 leads. Each wire is 4.8 mm. in diameter. The rotor has 180 slots, taking 4 naked wires 4 mm. in diameter.

Each motor is connected to the corresponding direct-current generator by a flexible coupling. Each dynamo generates 182 amp. at 550 volts. The armature contains 200 slots, each containing two spool halves, each consisting of three parallel wires 3.6 to 4.2 mm. in diameter.

FIG. 4.—INDUCTOR FOR ALTERNATOR.

The field has six spools connected in series and containing 3,300 turns of 1.6 to 2 mm. wire shunt winding and 3.5 turns of 1.5 x 100 mm. copper-tin compound winding.

This portion of the building contains a switchboard for control of the motor-generator sets and of the polyphase current from the upper works. The latter is transmitted underground by two cables of 3 x 60 mm. cross-section. Besides switches for controlling these cables the board contains an ammeter for each motor, three-pole circuit-breaker, voltmeter, wattmeter and safety devices. The direct-current part of the board contains for each generator an ammeter, voltmeter, two-pole switch and regulator. A two-pole switch is used to connect the generators and buffer battery in parallel. Two double-pole switches are used to permit the generators to run either as shunt or compound machines, the first being the case when the generators are in parallel with the battery and the second when the battery is out of service. Another double-pole switch serves to connect the battery halves in parallel or series. An ammeter and voltmeter are used to measure the current generated. Each of the outgoing feeders is controlled by an ammeter, wattmeter and a switch having a device for testing for short-circuits. Lightning arresters and other devices are placed in the housing.

UPPER POWER STATION.

This station is built of iron and brick with a roof of wood and cement. The interior of the building contains a 10-ton crane operated by hand. The station is illuminated by two 14-amp. series arc lamps and 16 incandescent lamps.

One of the turbo-generator sets is owned by the Schaffhausen Cord Works, which, like the Schaffhausen Worsted Works, leases power from the city. Two turbo-generator sets are used for general distribution. The generators are all connected to the turbines by gearing. The latter two turbines were built by Escher, Wyss & Co., and the first mentioned by J. J. Rieter & Co., each for a capacity of 350 hp at 60 r.p.m. and a flow varying from 1,950 to 2,100 second-gallons.

The first-mentioned turbine is of the Jonval type and is connected to a 350-hp, three-phase generator, which at 170 r.p.m. gives 420 amp. per phase, 400 volts and 51 cycles. This generator is directly coupled to a 4-pole exciter, giving at 170 r.p.m. 150 amp. at 40 volts. A separate switchboard is used for this private installation.

The two other turbines are of Francis type and run at 60 r.p.m. The generators coupled to them are of the same size and type as the one used with the Worsted Works turbine. The exciters are direct-coupled and are similar to the one last described.

The switchboard for the control of these two generators and exciters consists of an iron framework having a white marble front. The exciter panel carries for each exciter one ammeter, voltmeter, double-pole switch lever and regulating hand wheel. Each generator panel carries an ammeter, voltmeter, wattmeter, lever for operating high-tension switch, handle for carbon circuit-breaker and hand wheel for regulating. The regulating wheels of the generators are connected by a Gall's chain. The general panel carries an ammeter and voltmeter for measuring the power sent to the lower station and a contact voltmeter with relays and acoustic signal. The panel housing contains transformers, resistances, etc.

Favoring Submarine Boats.

A report has been received at the War Department from a board of artillery officers, composed of Major Arthur Murray, Capt. C. J. Bailey and Capt. C. F. Parker, in regard to the recent test of the submarine boat *Protector* at Fort Adams, Mass. The report has been referred to the General Staff for consideration. The board recommends, in consequence of its conclusions, that five of these boats be purchased for use in submarine defence, as follows: One for the school of submarine defence, for experimental work; one for the eastern entrance of Long Island Sound, one for the entrance of Chesapeake Bay, one for San Francisco harbor and one for Puget Sound. The report says:

"The board believes that this type of submarine boat is a most valuable auxiliary to the fixed mine defence, and in cases where channels cannot be mined owing to depth, rough water, swift tides or width of channels, it will give the nearest approach to absolute protection now known to the board. The boat can lie for an indefinite time adjacent to the point to be defended in either cruising, awash or submerged condition, by its anchors or on the bottom ready for instant use, and practically independent of the state of the water and in telephonic connection with the shore, or can patrol a mined or unmined channel invisible to the enemy and able to discharge its torpedoes at all times. In narrow channels the boat or boats would have a fixed position with a telephone cable buoyed or anchored at the bottom. In wide channels they would patrol or lie in mid channel or where they could readily meet approaching vessels. With picket or scout boat, outside the mine field, or even at extreme range of gun fire, telephone communication can be sustained and information received and instructions sent for attacking approaching vessels.

"For an attack the boat shows great superiority over any existing means of attacking mine fields known to the board. It can run by any field, as installed at present, with but little or no danger from the explosion of any particular mine or from gun fire during the few seconds it exposes the sighting hood for observations and can attack at its pleasure vessels in the harbor. The board personally witnessed the ease with which cables can be grappled, raised and cut. While the boat is manœuvring on the bottom mine cables can be swept for, found and cut, or a diver can be sent out for that purpose. The board recommends consideration of the foregoing by the General Staff.

"The question of the use of the Whitehead torpedoes as part of the fixed mine defence, fired from tubes on shore, is now receiving consideration. Where channels are wide and water is swift this use of the Whitehead will be very limited. With boats of this type the Whitehead can, it is believed, be carried within certain effective range in all ordinary channels, and this alone will warrant the consideration asked for."

Petrus Peregrinus—Author of the Earliest Treatise on the Magnet, 1269.

BY BROTHER POTAMIAN, D.Sc., LOND.
PROFESSOR OF PHYSICS IN MANHATTAN COLLEGE, NEW YORK.

THE magnetic lore of classic antiquity was scanty indeed, being limited to the attraction which the lodestone manifests for iron. Lucretius (99-55 B.C.), however, in his poetical dissertation on the magnet, contained in *De Rerum Natura,* Book VI[1], recognizes magnetic repulsion and to some extent the magnetic field with its lines of force, for in verse 1040 he writes:

> Oft from the magnet, too, the steel recedes,
> Repelled by turns and re-attracted close.

And in 1042:

> And oft in brazen vessels, may we mark
> Ringlets of Samothrace, or fragments fine,
> Struck from the valid iron bounding high,
> When, close below, the magnet points its powers.

The poet Claudian (365-408 A.D.) wrote a short idyl on the attractive virtue of the lodestone and its symbolism; St. Augustine (354-430), in his work *De Civitate Dei,* records the fact that a lodestone, held under a silver plate, draws after it a scrap of iron lying on the plate. Abbot Neckam, the Augustinian (1157-1217), distinguishes between the properties of the two ends of the lodestone, and gives in his *De Utensilibus,* what is perhaps the earliest reference to the mariner's compass that we have. Albertus Magnus, the Dominican (1193-1280), in his treatise, *De Mineralibus,* enumerates different kinds of natural magnets and states some of the properties commonly attributed to them; the minstrel, Guyot de Provins, in a famous satirical poem, written about 1208, refers to the directive quality of the lodestone and its use in navigation, as do also Cardinal de Vitry in his *Historia Orientalis* (1215-1220); Brunetto Latini, poet, orator and philosopher, in his *Trésor de toutes Choses,* printed in Paris in 1260; Raymond Lully, the Enlightened Doctor, in his treatise, *De Contemplatione,* begun in 1272, and Guido Guinicelli, the poet-priest of Bologna, who died in 1276.

The authors of these learned works were too busy with their pen to find time to devote to the close and prolonged study of natural phenomena necessary for fruitful discovery, and so had to content themselves with recording and discussing in their tomes the scientific knowledge of their age without making any notable additions to it.

But this was not the case with such contemporaries of theirs, as Roger Bacon, the Franciscan, and his Gallic friend, Pierre de Maricourt, commonly called Petrus Peregrinus, the subject of the present notice, a man of academic culture and of a practical rather than speculative turn of mind. Of the early years of Peregrinus, nothing is known save that he studied, probably, at the University of Paris, and that he graduated with the highest scholastic honors. He owes his surname to the village of Maricourt, in Picardy, and the appellation Peregrinus, or Pilgrim, to his having visited the Holy Land as a member of one of the crusading expeditions of the time.

In 1269 we find him in the engineering corps of the French army then besieging Lucera, in southern Italy, which had revolted from the authority of its French master, Charles of Anjou. To Peregrinus was assigned the work of fortifying the camp and laying mines as well as of constructing engines for projecting stones and fire-balls into the beleaguered city.

It was in the midst of such warlike preoccupations that the idea seems to have occurred to him of devising a piece of mechanism to keep the astronomical sphere of Archimedes in uniform rotation for a definite time. In the course of his work over the new motor, Peregrinus was gradually led to consider the more fascinating problem of perpetual motion itself with the result that he showed, at least diagrammatically, and to his own evident satisfaction, how a wheel might be driven round forever by the power of magnetic attraction. "This is the first recorded contrivance of the kind," writes Dr. Park Benjamin, in his "Intellectual Rise in Electricity," "which came into the world and probably served a good purpose," p. 166. "It was the beginning of that arch-delusion in mechanics which ran for centuries parallel with the arch-delusion in chemistry and with consequences very similar," p. 168.

Elated over his imaginary success, Peregrinus hastened to inform a friend of his at home; and that his friend might the more readily comprehend the mechanism of the motor and the functions of its parts, he proceeds to set forth in a methodical manner all the properties of the lodestone, most of which he himself had discovered. It is a fortunate circumstance that this Picard friend of his was not a man learned in the sciences, otherwise we would probably never have had the remarkable exposition which Peregrinus gives of the phenomena and laws of magnetism. This letter of 3,500 words is the first great landmark in the domain of magnetic philosophy, the next being Gilbert's *De Magnete,* in 1600.

The letter was addressed to Sigerus de Foucaucourt, his "amicorum intimus," the dearest of friends. A more enlightened friend, however, than the knight of Foucaucourt was Roger Bacon, who

FIG. 1.—DOUBLE-PIVOTED NEEDLE OF PEREGRINUS, AFTER BERTELLI.

(*The magnet is arrow-shaped. The second needle is made of silver or copper, a non-magnetic substance; it was probably intended to be used as a pointer.*)

held Peregrinus in the very highest esteem, as the following glowing testimony shows: "There are but two perfect mathematicians," wrote the English monk, "John of London and Petrus de Maharne-Curia, a Picard." Further on in his *Opus Tertium,* Bacon thus appraises the merits of the Picard: "I know of only one person who deserves praise for his work in experimental philosophy, for he does not care for the discourses of men and their wordy warfare, but quietly and diligently pursues the works of wisdom. Therefore, what others grope after blindly, as bats in the evening twilight, this man contemplates in all their brilliancy because he is a master of experiment. Hence, he knows all natural science whether pertaining to medicine and alchemy, or to matters celestial and terrestrial. He has worked diligently in the smelting of ores as also in the working of minerals; he is thoroughly acquainted with all sorts of arms and implements used in military service and in hunting, besides which he is skilled in agriculture and in the measurement of lands. It is impossible to write a useful or correct treatise in experimental philosophy without mentioning this man's name. Moreover, he

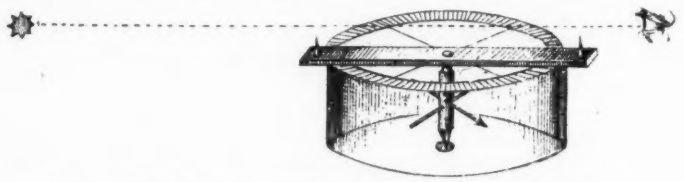


FIG. 2.—GRADUATED COMPASS OF PEREGRINUS, AFTER BERTELLI.

(*The Azimuth bar moves independently of the magnet, and carries a pair of terminal pins for sighting a star near the horizon.*)

pursues knowledge for its own sake; for if he wished to obtain royal favor he could easily find sovereigns who would honor and enrich him."

This last statement is worthy of the best utterances of the twentieth or any other century. Say what they will, the most ardent pleaders of our day for original work and laboratory methods cannot surpass the Franciscan monk of the thirteenth century, in his denunciation of mere book learning or in his advocacy of experiment and research, while in Peregrinus, the mediævalist, they have Bacon's impersonation of what a student of science ought to be. He was a hard worker, not a mere theorizer, preferring, Procrustean-like, to make theory fit the facts rather than facts the theory; he was a brilliant discoverer who knew at the same time how to use his discoveries for the benefit of mankind; he was a pioneer of science and a leader in the progress of the world.

An analysis of the "Epistola" shows that

[1] With very few exceptions all the works referred to in this notice will be found in the Wheeler Collection in the Library of the American Institute of Electrical Engineers.

(*a*) Peregrinus was the first to assign a definite position to the poles of a lodestone, and to give directions for determining which is north and which south;

(*b*) He proved that unlike poles attract each other, and that similar ones repel;

(*c*) He established by experiment that every fragment of a lodestone, however small, is a complete magnet, thus anticipating one of our fundamental laboratory illustrations of the molecular theory;

(*d*) He recognized that a pole of a magnet may neutralize a weaker one of the same name, and even reverse its polarity;

(*e*) He was the first to pivot a magnetized needle and surround it with a graduated circle, Figs. 1 and 2;[2]

(*f*) He determined the position of an object by its magnetic bearing as done to-day in compass surveying; and

(*g*) He introduced into his perpetual-motion machine, Fig. 3, the idea of a magnetic motor, a clever idea, indeed, for a thirteenth century engineer.

This rapid summary will serve to show that the letter of Peregrinus is one of great interest in physics as well as in navigation and geodesy. For nearly three centuries it lay unnoticed among the libraries of Europe, but it did not escape Gilbert, who makes frequent mention of it in his *De Magnete*, 1600; nor the illustrious

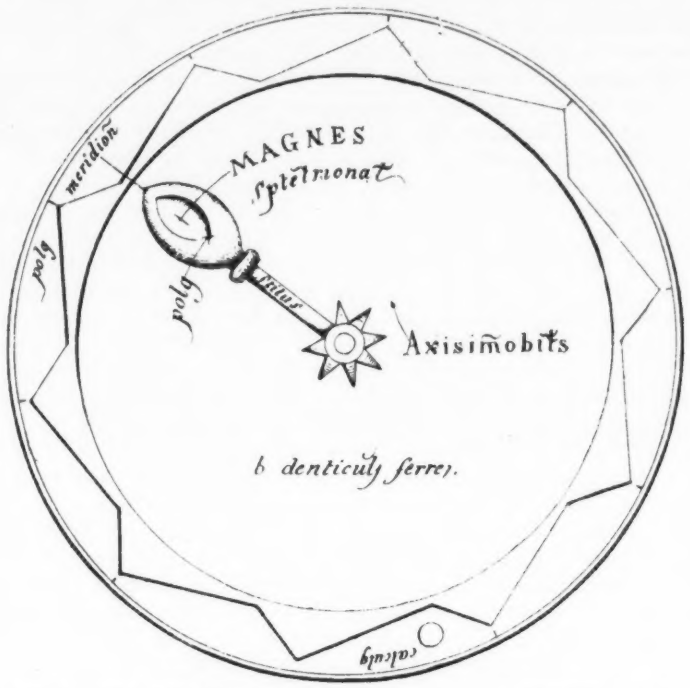


FIG. 3.—THE CONTINUOUSLY-MOVING WHEEL, OR MAGNETIC MOTOR, OF PEREGRINUS, AFTER GASSER.

Jesuit writers, Cabæus, who refers to it in his *Philosophia Magnetica*, 1629, and Kircher, who quotes from it in his *De Arte Magnetica*, 1641; it was well known to Jean Taisnier, the Belgian plagiarist, who transferred a great part of it verbatim to the pages of his *De Natura Magnetis*, 1562, without a word of acknowledgement. By this piece of fraud Taisnier acquired considerable celebrity, a fact that goes to show the meritorious character of the work which he unscrupulously copied.

This memorable letter is divided into two parts: the first contains ten chapters on the general properties of the lodestone; the second has but three chapters, and shows how the author proposed to use a lodestone for the purpose of producing continuous rotation.

There are many manuscript copies of the letter in European libraries: the Bodleian has six; the Vatican, two; Trinity College, Dublin, one; the Bibliothèque Nationale, Paris, one; Leyden, Geneva and Turin, one each. The Leyden MS. has acquired special notoriety from a passage which appears near the end of it in which reference is made to magnetic declination and its value given; but Prof. W. Wenkebach, of The Hague, has shown[3] that the lines are spurious, having been interpolated in the manuscript in the early part of the sixteenth century.

The Leyden manuscript has also led some writers to believe in a fictitious author of the letter, one Peter Adsiger, or Petrus Adsigerus. As said above, Sigerus was the name of his countryman, to whom Peregrinus addressed his letter, the *Epistola ad Sigerum*, from the trenches at Lucera, in August, 1269.

The first printed edition, now very rare, was prepared by Achilles Gasser, a physician of Lindau, a man well versed in mathematics, astronomy, history and philosophy. The work was printed in Augsburg in 1558. A copy of this early print is among the treasures of the Wheeler collection in the library of the American Institute of Electrical Engineers, New York. It was from this text that the translation which will follow this introductory notice was made.

Besides the Latin edition of Gasser, 1558, there is also that of Bertelli, 1868, and Hellmann, 1898. Bertelli's is an exhaustive and learned work in which the Barnabite monk, sometimes called by mistake, Barnabita, instead of Bertelli, collates and compares the readings of the two Vatican codices with other texts, adding copious references and explanatory notes. It appeared in the *Bulletino di Biografia e di Storia delle Scienze Mathematiche e Fisiche* for 1868.

Of translations, we have that which Richard Eden made from Taisnier's pirated extracts, the first dated edition appearing in 1579. Cavallo's *Treatise on Magnetism*, 1800, also contains some of the more remarkable passages; Libri's *Histoire des Mathématiques*, 1838, has a full version made from an original manuscript in the Bibliothèque Nationale. The only complete English translation that we have, appeared in 1902 from the scholarly pen of Prof. Silvanus P. Thompson, of London. It is an *édition de luxe* beautifully rubricated, but limited to 250 copies. The translation was based on the texts of Gasser and Hellmann, amended by reference to a manuscript in the author's possession, dated 1391. We are informed that Mr. Fleury P. Mottelay, of New York, the learned translator of Gilbert's *De Magnete*, possesses a manuscript version by Prof. Peirce, of Harvard, of the Paris codex, of which he made a careful study in an endeavor to decipher the illegible parts.

[2] It is probable that Flavio Gioja, some fifty years later added the compass-card and attached it to the magnet.

[3] Annali di Matematica Pura ed Applicata, 1865.

Predetermination of Transformer Regulation.

BY EMERSON G. REED.

THE predetermination of the regulation of a given transformer from its design is a very simple matter in the case of a non-inductive load. With such a load the lost voltage, neglecting the effects of hysteresis and eddy currents, is the resistance drop in primary and secondary winding. Due to the effects of magnetic leakage, that is leakage of lines of force between primary and secondary winding, it becomes a more difficult matter to predetermine the regulation with an inductive or capacity load. The amount of this leakage depends upon the shape of the transformer, the relative

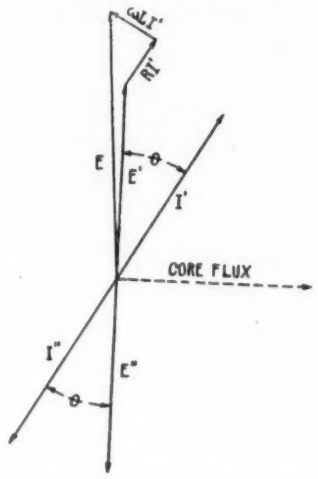


FIG. 1.—TRANSFORMER REGULATION.

position of primary and secondary windings, the number of primary turns and upon the current in the coils.

It is the object of this article to give some examples of a method of calculating the effects of this leakage which the writer has used with success in a large number of cases.

It can be shown that the effect of this magnetic leakage is equivalent to an outside inductance, L, connected in series with the primary winding.

Imagine a transformer (Fig. 1) whose secondary e.m.f. is E'', supplying current I'' through such a load that the angle of lag between

E'' and I'' is Θ. The angle between I' and E', the primary counterparts of E'' and I'', is also Θ.

The primary impressed e.m.f., E, is made up of three components, the part E', the resistance drop RI', and the part $\omega L I'$ lost in the inductance L. The quantity R may be called the equivalent primary resistance of the transformer and in like manner the quantity L may be called the equivalent primary inductance ($\omega = 2\pi f$, f being the frequency of the alternating current).

We may reconstruct the part of Fig. 1, in which we are particularly interested, to larger scale and study it in detail. (See Fig. 2.)

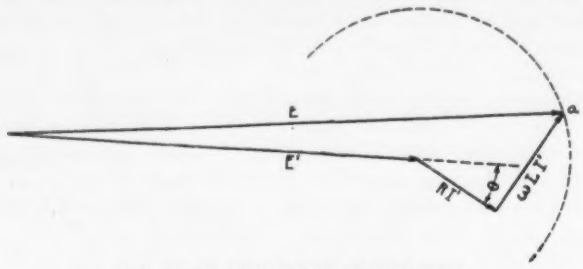


FIG. 2.—TRANSFORMER REGULATION.

The point a may take any position on the dotted circle depending on the value of the angle Θ. The part in which we are now interested is the calculation of the quantity L.

It can be shown that

$$L = 4\pi n^2 \frac{\lambda}{l}\left[\frac{X+Y}{3} + g\right]$$

(See Franklin & Williamson's "Alternating Currents" and J. P. Jackson's "Alternating-Current Machinery.")

In this equation, n is the number of primary turns and the quantities X, Y, g and λ are shown in Fig. 3. When the quantities are

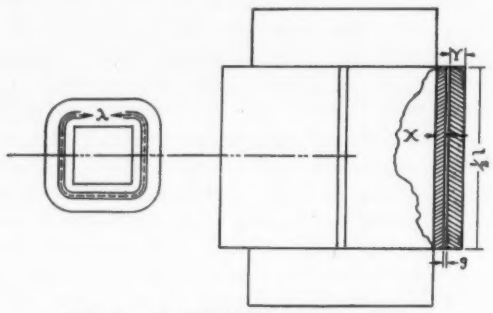


FIG. 3.—TRANSFORMER REGULATION.

given in c.g.s. units, L will be expressed in centimeters, which, when divided by 10^9, gives henrys.

When L has been determined, it is an easy matter to work out graphically from Fig. 2 the value of E, and from thence the regulation. It is more accurate to determine analytically the value of E, as the quantity EI' and $\omega L I'$ are small compared to E'.

DATA ON LINE OF COMMERCIAL TRANSFORMERS.

K.W. capacity.	Per cent core loss.	$\frac{\lambda}{l}$	$\frac{X+Y}{3}+g$	L	Per cent RI'	Per cent $\omega L I'$	Per cent impedance drop.
½	4.40	1.10	1.05	.363	3.60	1.73	4.00
1	2.80	1.07	1.08	.192	3.20	1.80	3.68
1½	2.34	1.05	1.12	.135	2.90	1.90	3.47
2	2.00	1.03	1.15	.104	2.60	1.95	3.25
2½	1.80	1.00	1.17	.0852	2.42	2.00	3.14
3	1.67	.99	1.20	.0750	2.33	2.10	3.13
4	1.52	.95	1.25	.0585	2.18	2.20	3.10
5	1.40	.92	1.30	.0490	2.09	2.30	3.11
7½	1.23	.85	1.41	.0355	1.93	2.50	3.16
10	1.12	.81	1.50	.0288	1.83	2.70	3.26
12½	1.05	.78	1.60	.0245	1.74	2.88	3.36
15	.98	.76	1.67	.0215	1.68	3.03	3.46
20	.87	.73	1.80	.0178	1.60	3.35	3.71
25	.80	.71	1.92	.0154	1.55	3.60	3.92
30	.76	.70	2.02	.0137	1.50	3.85	4.13
40	.69	.69	2.20	.0115	1.38	4.30	4.52
50	.65	.68	2.40	.0101	1.29	4.70	4.90

To check the calculated results after the transformer has been built, the secondary may be short-circuited and voltage applied to the primary until full lead current flows through the secondary. The primary applied or the impedance voltage is the vector sum of RI' and $\omega L I'$.

The preceding table gives the calculated data on a line of commercial core-type transformers. The calculated values of impedance voltage were found to correspond very closely to the experimental values.

Calculation of the Equivalent Ampere-Turns of Windings for Single and Polyphase Currents.—I.

BY C. F. GUILBERT.

THE calculation of the mean ampere-turns produced by alternating currents in the armature of an alternator, or in the primary or secondary windings of an asynchronous motor, has been treated by several authors, and for the first time by Prof. Blondel in his interesting study on "rotary fields."[1]

Unfortunately, Prof. Blondel, as well as most writers who have followed him, gives only the result of calculations in the form of tabulations, and then only for the case of windings where the slots of the same phase are placed, for each pole, one following the other. Such cases we shall designate as separate phase windings. Though this type of winding is equally applicable to coils and bars, at times it is desirable to utilize in an alternator with a revolving armature, a direct-current winding. This is particularly true in the case of self-exciting alternators, and sometimes, notwithstanding the recognized inherent defects of this kind of winding, for the rotor and stator of asynchronous motors. Such direct-current windings we shall designate as superposed phase windings. The study printed in these columns in issues of October, November and December, 1902, on the reaction of alternator armatures, led to a general formula admitting of the calculation of the equivalent m.m.f. per pole of a single-phase or polyphase winding, of the separate phase type in the latter case. This formula includes the case treated by Prof. Blondel.

The determination of the equivalent m.m.f. of an elementary coil of a winding, which was the starting point of the study just mentioned, also enables the establishment of formulas relating to the case of superposed windings. The present object is to deduce formulas of simple form for the cases apt to occur. First, however, we shall give briefly and in a manner much more simple than in the above-mentioned articles, the method of finding an expression for the equivalent m.m.f. of any elementary coil of an alternating-current winding, limiting it, however, to the case of asynchronous motors—that is, to the case in which the width of the flux is always equal to the polar step.

EQUIVALENT M.M.F. OF AN ELEMENTARY COIL.

To determine the equivalent m.m.f. of a coil of N turns during a half period—that is to say, the continuous m.m.f. producing a flux equal to the useful turning flux—we will calculate the m.m.f. of the field for any point of the armature (supposed to have a speed corresponding to that of synchronism) for all the relative positions having a half period; then the mean value of that m.m.f. at the point considered, and finally the mean m.m.f. for all the points comprised in the width of a polar step, a.

$$\text{Let } i = I_0 \cos\frac{\pi x}{a} \qquad x = \frac{2at}{T}$$

be the expression for the assumed maximum current at the moment when the axes of the field and armature poles coincide, I_0 being the maximum value of the current $I_0' = I\sqrt{2}$ for an output of current I, and x the variable phase displacement, during rotation, of the axis of one field pole with respect to the corresponding armature pole. Consider (Fig. 1) a point A of the armature at a distance y from the pole axis, and the variation at that point of the m.m.f. during a half period.

Let b be the peripheral length of a coil between the axes of two slots containing it. So long as the displacement is less than $\frac{b}{2} - y$, the point remains under the inducing coil and the m.m.f. decreases

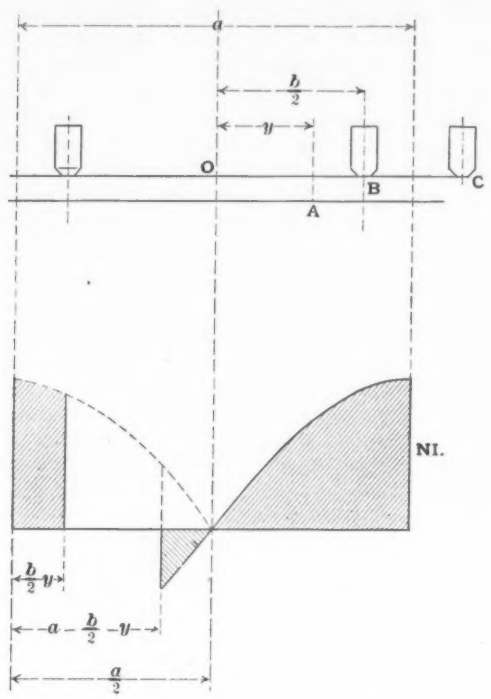
[1] A. Blondel. Quelques propriétés générales des champs magnétiques tournants. *Eclairage Electrique*, tome IV., page 24; 1895.

simply as $cos \frac{\pi x}{a}$ (Fig. 2). For $x = \frac{b}{2} - y$, the line of force passing the given point does not leave the inducing coil, the m.m.f. falls to zero and remains so until the displacement becomes greater than

$$OB + BC = \frac{b}{2} - y + a = a - y - \frac{b}{2}$$

From this moment the m.m.f. changes sign, since it passes under the elementary coil of the following field pole. It diminishes in absolute value to zero for a displacement equal to $\frac{a}{2}$, then increases again, after having changed sign with the current, until the end of the half period.

We will obtain the mean value of the m.m.f. at the given point by



FIGS. 1 AND 2.—CALCULATION OF AMPERE-TURNS.

referring to the hatched surface and taking account of the negative part. It is easily seen that this surface has for expression,

$$2 \int_0^{a-y-\frac{b}{2}} N I_0 \cos \frac{\pi x}{a} \, dx - \int_{\frac{b}{2}-y}^{a-\frac{b}{2}-y} N I_0 \cos \frac{\pi x}{a} \, dx$$

which reduces to $\frac{2}{\pi} \sin \frac{b}{a} \frac{\pi}{2} \cos \frac{\pi y}{a} N I_0$.

To obtain the mean m.m.f. over the width of the polar step, it suffices to take, as previously stated, the mean of all the means when y varies from $-\frac{a}{2}$ to $+\frac{a}{2}$, whence

$$\mathfrak{F} = \frac{1}{b} \frac{2}{\pi} \sin \frac{b}{a} \frac{n}{2} N I_0 \int_{-\frac{a}{2}}^{+\frac{a}{2}} \cos \frac{\pi y}{a} \, dy,$$

which reduces to $\frac{4}{\pi^2} \sin \frac{b}{a} \frac{\pi}{2} N I_0$; and substituting the value $I \sqrt{2}$ for I_0 we have

$$\mathfrak{F} = \frac{4}{\pi^2} \sin \frac{b}{a} \frac{\pi}{2} N I \sqrt{2}.$$

When each coil of the armature comprises several concentric coils and separated from each other by two slots, it suffices, evidently, to apply the formula to each and take the sum of the results, in virtue of the principle that the integral of a sum is equal to the sum of the integrals of the parts. This will be done in the next part of this article.

The Gas Engine for Central Station Service.

At the February meeting of the New York Electrical Society Mr. Ralph D. Mershon read a paper with the above title, giving the results of a recent study of the engineering aspects of the gas engine question, in the course of which Mr. Mershon visited most of the large gas engine installations and manufactories both in this country and abroad. The paper sketches the theory of the gas engine, points out the important bearing of compression as affecting the initial temperature, and describes in detail the four-cycle and two-cycle types of engines.

Taking up the subject of governing, it is stated that only two methods have been used to any great extent practically. One of these is the method used with the original Otto engine and still much employed, especially with engines of the older type. This method consists in causing the engine to miss one or more working strokes. That is, instead of there being a working stroke in every four there would at light loads be a working stroke in every eight or every twelve, depending upon the load which the engine was carrying. This method of governing has the disadvantage of requiring a heavy fly-wheel, and that even with a heavy fly-wheel there will be considerable variation in speed. It has the advantage, however, of high efficiency at all loads, since whether the load be heavy or light the quality of the mixture and the compression previous to ignition are the same. The irregularity of the speed, however, consequent on this method of operation is such as to render it unsuitable for many kinds of work, especially for the driving of alternators in parallel.

The method usually employed, therefore, in governing gas engines, especially those of large sizes, and for electrical work, is that of varying the amount of mixture admitted to the cylinder at the same time endeavoring to keep its quality constant. With heavy loads when the engine is taking a cylinder full or practically full of explosive mixtures, the mixture can be suited for the compression which takes place, but with lighter loads it is evident that since the cylinder must be full the only way to preserve the quality of the mixture the same or approximately the same will be to endeavor to stratify the contents of the cylinder. That is, to first admit air to the cylinder and then a layer of the mixture, endeavoring to admit the mixture in such a way that it will not mix with the air, or at any rate to only a small extent, and so that at the back end of the cylinder, at least, there shall be a mixture sufficiently rich to properly ignite under the compression which has taken place. Whether or not this stratification actually does take place has been the subject of considerable dispute, but whether this theory be wholly or only partially correct or not correct at all, the fact remains that engines are operated successfully in the manner described. In one engine, at least, that of M. Letombe, the endeavor has been made to secure reliability in the matter of ignition independently of any question of stratification by making the compression higher at light loads, thus not only making the ignition more certain, but also increasing the efficiency of the engine at light loads over what it would be without the increase of compression.

After developing the principles of gas generators, the paper describes a particular form, represented in Fig. 1. At the left is shown the generator filled with the fuel from which the gas is to be obtained. This fuel burns at the bottom of the generator by reason of the air admitted to it at that point through the grate bars shown. The air, however, is not admitted by itself but is forced in along with and by means of a steam jet entering the fire box below the grate bars by way of the pipe shown, the steam being supplied by the boiler *B*. The mixture of air and steam coming in contact with the hot fuel at the grate bars, the air burns a portion of the fuel,

thus forming carbonic oxide gas and supplying heat to split up the steam into its elements, the oxygen of the steam combining with a certain proportion of the incandescent carbon to form carbonous oxide. As this combination of carbonic oxide, carbonous oxide and hydrogen passes up through the hot bed of carbon, the carbonic oxide takes up an additional atom of carbon, forming carbonous oxide. There passes over the generator, therefore, by way of the pipe *B*, a mixture of hydrogen, carbonous oxide and the nitrogen contained in the air required for the process along with a small proportion of carbonic oxide. The generator is fed as shown by a properly sealed opening at the top, so that it may be charged without interfering with its operation.

After leaving the gas generator the hot gases pass out through the pipe *B*, heating in their course the water in the boiler as previously

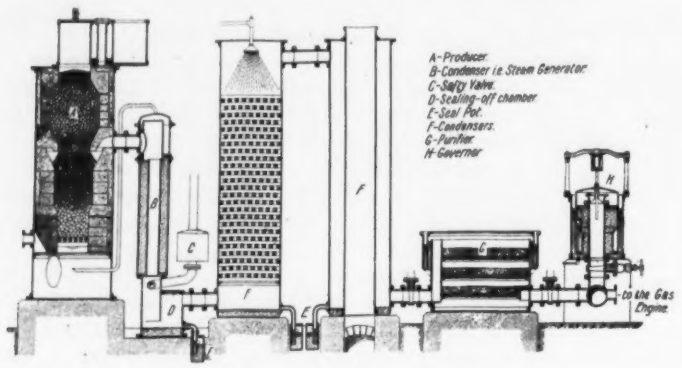


FIG. I.—GAS GENERATOR.

mentioned and forming the steam for use in the generator. The gases then pass into the scrubber and the cooling chamber, *F*, *F*, in which the gas is cooled and cleaned by a spray of water sent through a checker work or through loosely piled coke. It then passes through the purifier, *G*, which removes such dust as there may remain in it and takes out the superfluous moisture. *H* is a small gas tank or equalizer for reducing the pulsation in the main occurring at the time when the engine is drawing a supply of gas.

There are many other forms of gas generators, but most of them operate on a principle simliar to that above described. This particular generator gives satisfactory results only with anthracite coal or coke. The generators for using bituminous coal require a somewhat different method of construction and operation from that described, because of the fact that with bituminous coal there are given off a number of tar products which must be either all converted into gas or completely washed from the gas before it is used in the engine. If the gas contains any considerable amount of these tar products, there will be a great deal of trouble in the operation of the engine due to the gumming up of the cylinders and valves. The problem of a gas generator for bituminous coal has not in the past received as much attention as that for anthracite coal or coke, and is not now so generally in use. There are, however, a number of bituminous coal gas generators on the market at this time, although most of them depend for their success upon a complete washing of all tar products from the gas before it is used. There are some generators, however, which may be now considered as having passed the experimental stage in which all or practically all of the products of the coal are converted into gas and the amount of washing or scrubbing required is, therefore, comparatively small. It seems pretty certain that a number of these generators of different makes will shortly be upon the market. Mr. Mershon stated that while in Germany he saw two generators of this kind in operation, one of which, both as to the principle used and as to the results which had been so far obtained, seemed to give every evidence of fulfilling the requirements. In a number of the bituminous generators in which the products of distillation are not all converted into gas there are obtained in the course of purification by-products of sufficient value to enable in some cases a return of about one dollar per ton of coal used over and above the expenses of operating the plant; such a showing as this cannot, however, be made except in plants of considerable size, and in small plants the installation of a by-product plant is not worth considering. The thermal efficiency of these gas generating plants is generally about 80 per cent.; that is, the gas produced by them contains about 80 per cent. of the total calorific power of the coal used.

Mr. Mershon stated that the cost of the gas engine is considerably in excess of that of the steam engine, and as compared with the steam turbine the discrepancy is even greater. There is a point of difference between the steam prime-movers and the gas engine which further exaggerates any relative cost which may be given per horse-power. The steam turbine and steam engine have a certain amount of overload capacity. That is to say, they are capable of operating, though at somewhat impaired efficiency, at loads considerably in excess of their rated output or the output at which they give the best performance. The gas engine, however, has, properly, no overload capacity. Its performance improves up to the point where it cannot carry any further load and at which any further loading causes it to slow down. This is not strictly true for engines of the two-stroke type, which have a slight overload capacity beyond the point of best performance, but this overload capacity does not exceed 20 per cent. of the rating capacity and is probably less. With the four-stroke engine, however, the statement as regards overloads holds.

It is necessary, then, in purchasing gas engines to provide for a rated capacity approximately equal to the overload which will have to be carried at any time, so that a comparison of prices on the basis of the cost per horse-power does not always give a correct idea of the relative costs, because in the case of the gas engine we must provide for a greater total number of rated horse-power. The quoted prices on the gas engines in this country at the present time vary quite surprisingly. Depending on the maker quoting, the prices on a horse-power basis range from 60 per cent. greater than for a steam engine to over twice the steam engine figures. In comparing the gas engine with the steam turbine prices we find a still greater discrepancy. In order to make the comparison it is necessary to add to the cost of the gas engine, the price of a suitable alternator, since the steam turbines are always furnished with the alternator which they drive. If this is done it will result in a cost per kilowatt of output at least twice as great in the case of the gas engine as in the case of the steam turbine, and if the comparison be made on the basis of a suitable overload capacity, the discrepancy will be even greater.

The cost of the gas generating plant for use in connection with

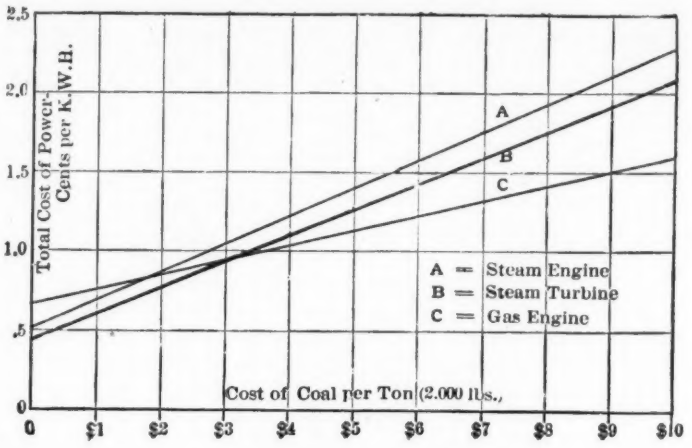


FIG. 2.—COMPARATIVE CURVES.

the gas engine may be taken as being about twice the cost of the steam boilers necessary for use in connection with a steam prime-motor. This is for a simple gas generator and cleaning plant, without any installation for the production of by-products.

It will be seen, therefore, that the cost of a gas engine plant, including the necessary gas generator, is considerably in excess of the cost of a steam plant for the same service, especially if the steam prime-movers be turbines. The cost of maintenance and the figure which must be taken for depreciation on such plant is, therefore, correspondingly higher, and the cost of the attendance also greater, since it requires a somewhat better class of men to handle a gas plant. On the other hand, the efficiency of the gas plant is very much better than that of the steam plant, the gas plant requiring for the same service about half the coal required by the steam engine plant and a little more than half that required by the steam turbine plant.

In order to give an idea as to the relative costs of electric power by the three types of plant, and the influence that the cost of fuel has upon the cost of power, figures were presented for a steam engine plant, a steam turbine plant and a gas engine plant, for the same service. In these figures everything is included properly chargeable against the cost of power.

It is assuming in each case that current is to be supplied to a load having a load factor of .5, and that the peak load is 1,500 kw. It is assumed that this load will be carried by four generators having a rated capacity of 400 kw each, and operating when necessary at 25 per cent. overload. The generators are to be cut in and out of service in such a way that the average efficiency of each unit will be the same as though it ran continuously at 75 per cent. of its rated capacity. The thermal value of the coal is taken as 12,500 B.T.U. per pound, and it is assumed that this coal will evaporate seven pounds of steam when burned under the boilers, and when used in the gas generators will produce gas having a total thermal value of 10,000 B.T.U. It is assumed that a steam pressure of 150 pounds is to be used and that the steam is to be superheated to 150° F. above its normal temperature. Under these conditions the following figures for performance are taken, being such as will be guaranteed by the makers of the various pieces of apparatus: Steam engine, 12 pounds per brake hp-hour; steam turbine, 18 pounds per kw-hour; gas engine, 10,000 B.T.U. per brake hp-hour.

Suitable modifications of these values were made to take care of the fact that the units are to run at 75 per cent. of their rating capacity, and to take care of condensation and auxiliaries in the case of the steam plants. Making use of these figures in connection with the costs necessary for such estimates, there were obtained the results embodied in the curves in Fig. 2. It is to be understood that these curves include everything properly chargeable against the cost of power, including interest, depreciation and renewals on the whole installation and supplies, labor and fuel. The line *A* shows the cost for a steam engine plant, *B* for a steam turbine plant, and *C* for a gas engine plant. The slope of these lines shows in each case the increase in power cost as the cost of the fuel increases. The point at which the line *C* crosses the other two lines shows the cost of fuel at which the gas engine plant is on a parity with the steam engine plant and the steam turbine, respectively, as regards the total cost of power. These curves give us an idea, therefore, of the cost of fuel at which it would begin to pay, under the present prices for apparatus, to install a gas engine plant rather than a steam plant. As will be seen from the curves, the gas engine plant and the steam engine are at a parity with coal costing about $1.85, while the point of equality with respect to the steam turbine plant is with coal at about $3.

It is believed that these curves show the relative performance of such plants under the condition assumed pretty fairly no matter what modifications might be made in the estimates, since while the modifications might change to some extent, the actual value for the cost of power, the relative value will not be much changed by a modification common to all of the plants. It should be borne in mind also that these figures are made on the assumption of a load having a load factor of .5, and that for more continuous service the gas engine will make a much better showing. It should also be borne in mind that these estimates are made without reference to any recovery of by-products, and that such recovery would very materially alter the showing made.

An inspection of these curves at the point where the value of the fuel is zero shows very plainly that, if, as it has sometimes been proposed to do, plants be installed at coal mines for the generation of power, a steam turbine and not a gas engine plant should be used unless a plant for the recovery of by-products be made a part of the installation.

The relative values here arrived at will no doubt have to be changed with the progress in the gas engine art. The gas engine equipment will become cheaper as its use becomes more general, and Mr. Mershon considers that this, in connection with the fact that some hard work is being done in the endeavor to produce a gas turbine, permits one to look forward to a time not far off when gas prime-movers of some sort will be installed instead of steam prime-movers.

Western Union and Wireless Telegraphy.

The Western Union Telegraph Company is now collecting and distributing messages for the marine service of the Marconi Wireless Telegraph Company of America. Postal Telegraph and Marconi have for some time past been working under a similar arrangement. The Marconi message for transmission to ocean steamers may now be accepted at any telegraph office in the United States or Canada.

Calculation of Motor Starting Rheostats.

BY F. MEURER AND A. SIMON.

IN the ELECTRICAL WORLD AND ENGINEER of January 9 Mr. A. H. Ford gives a method for the calculation of motor-starting rheostats, which appears to be the same method suggested in *Elektrotechnische Zeitschrift*, 1894, page 644, by Prof. Görges, for shunt motors. At the same time Mr. Görges gave a diagram for the various steps of the rheostat. This method seems to be little known in America, but has been familiar to engineers of Germany for years, where it is held in favor on account of its simplicity. The method is as follows, using the same notation as Mr. Ford:

It will be seen from equation (*a*) that the steps

$$Rm = a\,Ra\ (1+a)^{m-1}$$

follow a geometrical progression. The sum of the first m steps is:

$$R_1 + R_2 + R_3 + \ldots Rm = a\,Ra\ \frac{(1+a)^m - 1}{(1+a) - 1}$$

$$= Ra\ [(1+a)^m - 1].$$

Including the resistance of armature and connections, we have:

$$Ra + R_1 + R_2 + \ldots Rm = Ra\ (1+a)^m.$$

This equation follows also a geometrical progression, when m has in

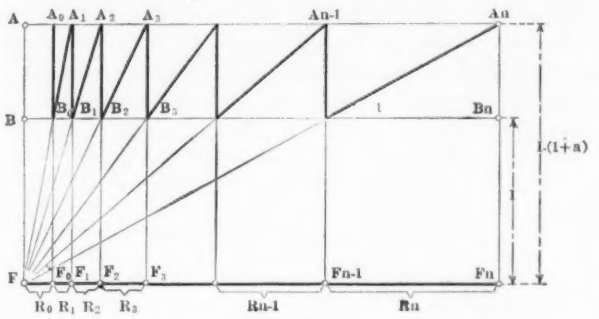


FIG. I.

turn values 1, 2, 3 . . . m . . . . n, and will give a geometrical construction of the steps of the resistance. Referring to Fig. 1,

$$F F_0 = Ra$$

and

$$\triangle\ F B_0 F_0 \infty F A_1 F_1;$$

therefore,

$$\frac{F F_1}{F F_0} = \frac{F_1 A_1}{F_0 B_0} = \frac{I\ (1+a)}{I} = 1 + a.$$

Further,

$$F F_1 = Ra\ (1+a) = Ra + R_1,$$

and

$$\frac{F F_2}{F F_1} = \frac{F_2 A_2}{F_1 B_1} = \frac{I\ (1+a)}{I} = 1 + a,$$

or $F F_2 = F F_1\ (1+a) = Ra\ (1+a)^2 = Ra + R_1 + R_2$, **etc.** Knowing Ra and assuming the minimum (I) and normal current (I_0) and $a > o$, the number of steps, n, is found from formula (b). In the above diagram the value of the various steps are, therefore, found sufficiently correct, without any calculation.

The same diagram also shows the speed of the armature at the time when the various steps are short-circuited, in the points $Bn-1$ . . . . . B_3, B_2, B_1, B_0, corresponding to the currents I and the time during which the lever has to touch the contact of this step, before the latter is cut out. At the moment, when the *mth* step is cut out,

$$Ea\,m = E - I\ (Ra + R_1 + \ldots + Rm)$$

$$= I\,Ra\ [(1+a)^n - (1+a)^m]$$

$Ea m$ the counter e.m.f. is proportional to the speed v; therefore, $v.m$ *prop* $(1+a)^n - (1+a)^m$.

Transferring the above developed relations to the diagram, the geometrical measuring is easily understood. Fig. 2 is the diagram of the speeds. The end of the starting period is of especial interest. In point B_0 the last step is short-circuited, the current rises for the last time to the value $I\ (1+a)$ to point A_0, and then it decreases according to the rule,

$$I_t = I_0 + [I\ (1 + a) - I_0]\ e^{-\frac{t}{T}},$$

accelerating the armature according to

$$v_t = v - (v - v_n)\ e^{-\frac{t}{T}},$$

where v is the constant speed for I_0; v_t and I_t the speed and current t seconds after the short-circuiting of the starter; T a constant depending on the moment of inertia of the rotating masses, the angular velocity and the resistance, R_a.

Owing to the asymptotic character of these equations, the constant and normal current and speed are reached after an infinite time; in

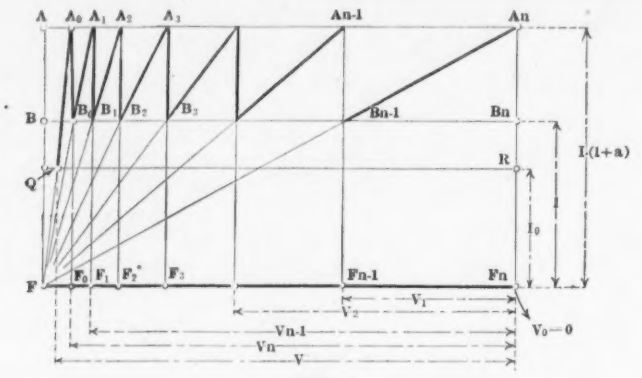


FIG. 2.

practice, however, this condition is reached in a short time. In Fig. 2 the constant speed for the current I_0 and the voltage E is $Q\,R$.

In the time that elapses between the touching of two successive steps there is an average excessive current above the normal current I_0 which is between the values $I\ (1 + a) - I_0$ and $I - I_0$. This current, which is of the same amount for all steps, accelerates the armature with an average acceleration as follows:

$$v_m - v_{m-1} = p.t,$$

$$v_m - v_{m-1} \text{ prop. } [(1 + a)^n - (1 + a)^{m-1} - (1 + a)^n + (1 + a)^m],$$

$$v_m - v_{m-1} \text{ prop. } (1 + a)^m - (1 + a)^{m-1},$$

$$\text{prop. } a\ (1 + a)^{m-1},$$

According to equation (a),

$$R_m = a\ R_a\ (1 + a)^{m-1};$$

therefore, t is proportional to R_m. It is found that the time, during which the lever has to touch each contact before touching the following one, is proportional to the resistance of the respective step. This relation is important for the dimensioning of the capacity of the resistance of each step, when the starter is to be designed for intermittent duty.

The three diagrams may be united in a single one, which contains all the points of interest in calculating a motor starter, the resistances of the various steps, the speeds and the starting times.

A simple way of finding the different steps with the slide rule is given by E. Pochin (*Elektrotechnische Zeitschrift* 97, p. 346). After

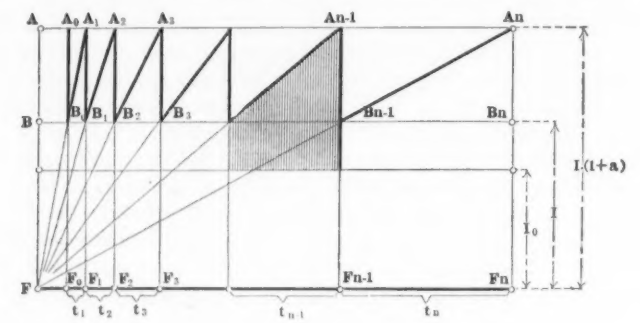


FIG. 3.

Mr. Görges, F. Erens (*Elektrotechnische Zeitschrift* 99), Neidt (*Elektrotechnische Zeitschrift* 99, No. 2), and Bragstadt gave simple diagrams for series motors, and Max Müller (*Elektrotechnische Zeitschrift* 02, p. 513), for dynamic brake rheostats for series motors. Similar diagrams have been developed for field rheostats for shunt dynamos and motors by Mr. Krause and others. On account of limited space, we cannot attempt to detail all of these methods, but would refer to the excellent book, "Die Gleichstrommaschine," by E. Arnold, Vol. II, where they are lucidly described.

The Design of Motor Starting Rheostats.

By Max Freimark.

The article of Mr. Arthur H. Ford in your issue of January 9 leads me to submit a similar and well-known method for designing motor-starting rheostats.

Assuming that the object is to make the starting current, always equal to the normal current i, $i_s = i$. If, in this case, R is the entire resistance of the armature, connections and starter, E the line e.m.f. (see Fig. 1), then we have the equation:

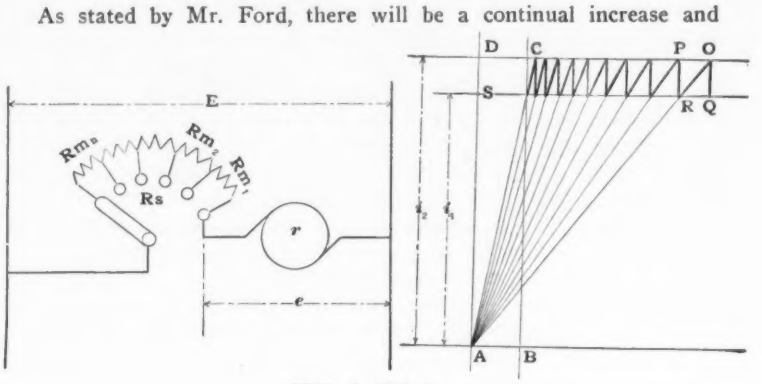
$$R = \frac{E}{i} = \frac{E}{i_s}.$$

If e is the motor e.m.f., r = the resistance of the motor, then $E - e = i\,R$, or $i_1 = \dfrac{E - e}{R_s + r}$, Rs being the starter resistance,

$$i_2 = \frac{E - e}{R_s + r - R_{m_n}},$$

when one section (R_{m_n}) is cut out.

As stated by Mr. Ford, there will be a continual increase and



FIGS. 1 AND 2.

decrease of the current between i_1 and i_2, as is to be seen from Fig. 2.

The ratio of these extreme currents may be λ

$$\lambda = \frac{i_2}{i_1}, \text{ or } \lambda = \frac{R_s + r}{R_s + r - R_{m_n}} = \frac{R}{R - R_{m_n}} = \frac{R}{R_{n-1}},$$

n being the number of sections.

$r_1 = r + R_{m_1}$;

$r_2 = r + R_{m_1} + R_{m_2}$; . . . . .

$r_n = r + R_{m_1} + R_{m_2} + \ldots + R_{m_{(n-1)}} + R_{m_n} = R$

$$\frac{r_n}{r_{n-1}} = \frac{r_1}{r} = \frac{r_2}{r_1}, \text{ etc.}$$

$r_1 = \lambda\ .\ r$;

$r_2 = \lambda\, r_1 = r\ .\ \lambda^2$ as $r_1 = \lambda\ .\ r$; . . . .

$r_n = \lambda\ .\ r_{n-1} = r\ .\ \lambda^n$

That is to say, the resistance must increase geometrically with λ.

$$\frac{r}{R} = a$$

When $i_s = i$ then $a = \varepsilon =$ per cent. e.m.f. loss, since

$$E = i_s\, R,$$

$$\varepsilon\ .\ E = i\ .\ r,$$

$$= \frac{i}{i_s}\ .\ \frac{r}{R} = a$$

As now $n = \dfrac{-\log a}{\log \lambda}$, the number n of sections is fixed by the

allowed drop of pressure in the armature.

The following table gives some usual values of a and n, and shows the influence of λ the ratio of i_2 and i_1:

a 0.03	0.04	0.05	n
λ			
2.02	1.91	1.82	5
1.42	1.58	1.35	10
1.26	1.24	1.22	15
1.19	1 17	1.16	20
1.12	1.11	1.10	30
1.09	1.08	1.08	40
1.06	1.055	1.05	60

The conditions are shown graphcally in Fig. 2, where

$$AB = CD = r,$$

$$QS = r_n\ ;\ RS = r_{n-1},\ \text{etc},$$

$$\frac{OD}{RS} = \frac{AD}{AS} = \frac{i_2}{i_1},$$

$$\frac{OD}{RS} = \frac{r_n}{r_{n-1}},$$

$$\frac{OD}{PD} = \frac{r_n}{r_{n-1}} = \lambda$$

The Choice of Wattmeters.

BY H. P. DAVIS.

I HAVE read with interest the views regarding the choice of wattmeters expressed by Messrs. MacGahan and Howe in recent issues of your journal. The important part played in electrical economy by the service meter makes this subject one worthy of careful consideration, and as it is possible that a comparison of the statements made by these gentlemen may be of some value, I beg to submit the following conclusions reached by a study of the subject as thus presented.

It is well to note that Mr. MacGahan and Mr. Howe agree in fundamentals, but differ in the application of theory to practice. They unite in saying that the prime requisite in a wattmeter is accuracy over a long period of time. They, however, take issue in regard to the way in which long-lived accuracy is to be attained, and the relative value placed upon various functions and features common to such instruments, and it seems to me that their differences are mainly those caused by the difference in their point of view. Mr. MacGahan favors a meter for which he claims accuracy within 2 per cent.; Mr. Howe insists that he does not find that such a claim is borne out by the meter with which he is familiar. Mr. MacGahan espouses a sealed meter in which the factory calibration is preserved intact; Mr. Howe thinks it preferable to furnish meters unsealed, that customers may have the ready access to the adjustments which he finds necessary. Mr. MacGahan asserts that the friction of the counting train is negligible; but Mr. Howe's observations lead him to believe to the contrary. Mr. MacGahan prefers a high ratio of torque to friction in conjunction with a light, movable element and reduced friction; Mr. Howe thinks the desired long-lived efficiency can best be secured by increasing the torque through the use of a heavier movable element with the increased jewel wear. Each of these gentlemen doubtless states the facts as he finds them in his personal experience, and a ready assent can be given to their assertions in the main, so far as they are the results of personal investigation in a limited field. It is only when a general application is made that their claims require especial comment.

Mr. MacGahan says that all the variations of actual service should not produce a maximum error in registration of over 2 per cent. of the rated capacity. This Mr. Howe denies, claiming that a variation in standards will ordinarily be 1 per cent., while a 10 per cent. variation in frequency or voltage will cause an error of an equal amount, making it possible for other influences to combine to produce an error in excess of the 2 per cent. Mr. Howe may find such conditions prevailing in his field, but meter experts who are accustomed to the handling and testing of the sealed type of meters of high sensibility and with light, movable elements, can testify that the maximum aberration for a 10 per cent. variation in frequency and voltage rarely exceed ½ per cent., leaving practically 1½ per cent. of margin for variations in standards, errors in observations, etc.

Mr. MacGahan's contention that a sealed meter possesses material advantages over one not sealed, and Mr. Howe's arguments in favor of an open instrument simply carry along an old discussion which must, after all, be decided by the individual companies using wattmeters, and by their meter experts. Mr. Howe assumes that a sealed meter is a delicate and intricate one, which the manufacturers dare not leave open, and that the presence of the seal discourages the owner from making his own repairs. Would it not be more logical to assume that a meter which can be finally adjusted at the factory for use upon a circuit, can be shipped to destination, carried to the point of installation in the lineman's wagon and put into service with no attention from the meter expert, possesses an unusual degree of strength and stability? Instead of the absence of a seal being a virtue and a feature to be desired, is not the ordinary meter expert liable to think it a weakness, particularly when he reflects that the meter was left unsealed because he must make a final adjustment of the movable element after the meter is installed, its construction being such that it cannot be shipped ready for service?

All manufacturers of wattmeters, whether sealed or open, guarantee the materials and workmanship of their instruments. If the purchaser of a sealed meter does not care for the advantages thus gained, he can easily break the seals, and obtain exactly the same conditions as those given by an unsealed meter. He will have an instrument, the workmanship and material of which are guaranteed, but without any means of knowing whether the adjustments have been tampered with, and, therefore, no guaranty of the calibration.

The benefits derived from preserving the factory calibration made by trained experts are constantly winning new recognition, as instances multiply where this calibration has proven of value. In one installation, after 1,400 wattmeters had been used for over two years under the factory seal, only 18 of them required any attention, and these were easily restored to their original accuracy by the local meter expert, who did not find the seal any impediment to his making new adjustments or repairs. The ordinary meter man, who desires to give his employers the best of results, would naturally be expected to prefer a guaranteed calibration of known accuracy to the dubious privilege of freely changing adjustments when such changes are made an inevitable part of the operation of installation.

Mr. MacGahan claims that the friction of the counting train is negligible, but Mr. Howe affirms that such is not the case. Apparently the difference is again one of construction. Mr. MacGahan's statement is evidently based upon the use of a pinion upon the shaft of the moving element, which engages the counting train, the inevitable worm being placed where the speed is lower and the leverage of the gears increased; while Mr. Howe's counter statement is as evidently based upon the fact that he has in consideration a meter with a worm upon the shaft, with greatly increased friction. Any meter expert who has at his command meters with the different forms of construction can easily demonstrate that while with the pinion and gear he cannot detect any difference in operation whether the counting train is connected or removed, there is a very appreciable decrease in friction when the counting train is removed from a meter which employs a worm on the shaft.

Mr. MacGahan declares for a high ratio of torque to friction, and Mr. Howe for a high torque with heavier movable element and consequent increase in friction. Now, both state that the prime requisite is length of accurate service. If it be true—as experience has amply shown—that wattmeters first develop weakness through wear in the jeweled bearing, does it not logically follow that any increase in friction which shortens the life of this bearing reduces the length of accurate service? A powerful drag or pull upon the rotating medium is of value in overcoming friction, particularly upon light loads, when the ratio of friction to torque is highest, since friction is a fixed quantity, while torque varies with the load; but any increase in torque gained at the expense of the life of the jewel is an injury rather than a benefit. The wise designer will first reduce the friction to the lowest possible point by using the best bearings he can devise and by lightening the weight of the movable element as much as he can and still have ample torque for accurate registry upon light loads for any length of time under normal conditions of jewel wear.

Hiccoughs Cured by Electricity.

Frank Green, of Trenton, N. J., was recently attacked with severe hiccoughing. After three days of suffering an electric current was, according to a dispatch from that city, applied to his body. At first light currents were used and afterwards increased in strength. Improvement was noted from the first application, and finally, with a sudden shock, the paroxysms ceased.

Telephone Transmitters.—VII.

BY ARTHUR V. ABBOTT, C.E.

Testing Transmitters and Receivers.—To determine the merit of transmitters or receivers is one of the most difficult of tests. This is chiefly because there is no recognized standard or unit of measure. People vary enormously both in their ability to talk and to understand, over a telephone line entirely apart from the ability of the apparatus to transmit and reproduce sound. Hence, what to one person seems sufficient will be perhaps more than adequate to another, and unsatisfactory to a third. It is common to test transmitters and receivers by arranging a circuit between two rooms out of earshot of each other, in one of which the transmitters are placed and in the other the receivers. An inspector at the transmitter end counts from one to ten in a rather loud, sustained tone into one instrument after the other, while another inspector at the receiving end forms the best conclusion he may as to the relative efficiency of the various instruments. While trained observers develop an astonishing skill in detecting differences in transmission, such a method compared with the more exact measurements of other branches of electrical engineering appears crude in the extreme.

To the practical man quality of transmission is proportional to the ability to understand each word individually without requiring his correspondent to repeat it, and that combination of transmitter and receiver is the best which, over lines of varying lengths, requires on the whole the least repetition. For testing purposes, therefore, it is necessary to provide a transmitter and receiver with which with all other instruments may be compared, and a variable line over which tests can be made. As there is no established standard instrument, it matters little what ones are selected for this purpose, for all results will be relative only. In a general way two of the best instruments obtainable should be taken, set aside for the purpose and used for nothing else. For the line nothing can excel an actual working line, but as tests should include trials over at least a thousand miles of wire, there are few who can avail themselves of such a plant, and it is equally difficult to carry on experiments on a commercial circuit. It is, therefore, better to build an artificial line exclusively for test purposes. For this purpose a number of coils of wire can be made each of which shall represent, by having the same resistance, inductance and capacity, a certain section, say ten or one hundred miles of line.

The artificial line is best made by preparing 220 spools of wood. Each spool should have a 1-in. hole through its center and be about 3½ in. over all in diameter and 3½ in. high. The flanges and core should be about ¼ in. thick, leaving a winding space about 3 in. x 3 in. The spools should be made of soft wood thoroughly baked and boiled in paraffine. To represent aerial lines No. 20 wire is a convenient size to use, while for cable lines No. 28 or No. 30. Each spool should be wound with sufficient wire to represent 10 miles of open wire or 1 mile of cable. To secure the proper inductance more or less of the wire can be wound non-inductively, so that each spool when finished shall have accurately the resistance and inductance of either 10 miles of open wire or 1 mile of cable. The necessary capacity is best secured by making a small condenser of tin-foil and paraffined paper, exactly like a sub-station condenser. For each pair of wire spools the condenser should have a capacity of .1 mf. and for each cable wire spool .08 mf. When completed a frame is to be prepared having two long rubber or glass rods. On each rod 110 coils, 10 representing 10 miles of cable wire, and 100 each representing 10 miles of open wire, are placed. Between the two rods a substantial wooden strip is arranged underneath which the condensers are secured, and on top of which there are a number of brass plugs similar to those used in Wheatstone bridges. A condenser is joined between each pair of coils, and all coils are connected in series through the plugs, so that each plug when in its place short-circuits a pair of coils. Thus any combination of cable and open wire up to 1,010 miles can be obtained. Such an apparatus can be built for about $500, and while seemingly elaborate and expensive is essential for the proper testing of telephone apparatus.

For actual trials there should be three inspectors—a speaker, a listener and a manipulator—for in order to avoid the unconscious error due to personal equation, neither the speaker nor the listener should know anything about the apparatus they are testing, which should be arranged in all cases entirely independently of their knowledge. The three rooms are necessarily entirely distinct from each other, both visibly and audibly. The transmitters should be placed in room No. 1, the artificial line in No. 2 (the middle one), and the receivers in No. 3. In the following method of testing the listener must be an expert stenographer, and the method consists in finding the percentage of errors between sentences uttered in the transmitter and those received with varying line length. The first thing is to determine the *error coefficient* of the speaker and listener. The speaker reads to the listener in the usual conversational tone, and at a fair rate of speed, 10 sections of 1,000 words each, of 10 different subjects. The listener then transcribes the 10 selections, and the manipulator compares the transcription with the original and counts the number of errors made. This is the *error coefficient* and is usually from 3 per cent. to 5 per cent. The manipulator then, unknown to both speaker and listener, adjusts either a transmitter or a receiver to be tested, for only one instrument can be tried at once. The speaker then reads to the listener over the telephone line 10 different selections of 1,000 words each. After each set of 1,000 words the manipulator changes the length of the line. The listener then transcribes the shorthand notes, the manipulator compares with the original and counts errors. The results may then be plotted as a function of line length, and by making a number of such tests with different transmitters and receivers quite accurate relative results can be secured.

The curves of Fig. 54 are illustrative of the method. The horizontal scale is the length of the artificial line in miles, while the left-hand scale is percentage of error. The line marked "error line" is the percentage of normal errors, when the speaker read directly to the stenographer. Curves *A*, *B* and *C* show the results of tests on three rather well-known types of transmitters working with the same receiver. Transmitter *A* showed the least percentage of error. Instrument *B* showed about 2 per cent. more error on short lines and 30 per cent. more on long lines, indicating a deficiency in volume. Instrument *C* was poorer than *B* on lines up to 200 miles, and subsequently gave marked falling off in volume.

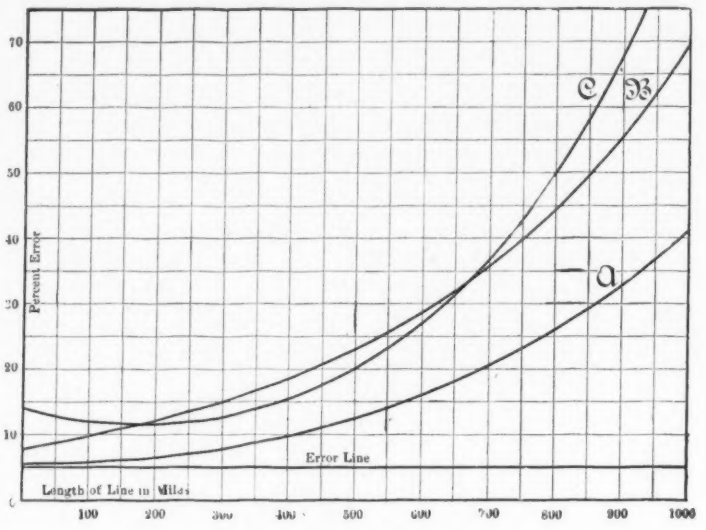


FIG. 54.—CURVES OF TESTS.

Tests as thus described show what may be termed the *general efficiency* of transmission. It is also well to compare volume by actuating the transmitter by an organ pipe, blown by a blast of constant pressure, and measuring the distance from the ear of an observer at which the sound first becomes audible. The listener should be blindfolded and the manipulator should noiselessly move the receiver to and from the ear of the listener along a graduated scale, noting both the distance at which the sound is first perceived, when the instrument *approaches* the ear, and the point at which sound *fails* to be heard when it recedes. The mean of a number of such tests gives relative volume. To test for articulation the speaker should read to the listener a list of a thousand words of great similarity, such as fine, rhyme, dine, sign, mine, etc.; mowing, rowing, throwing, going, etc. Also the letters of the alphabet in heterogeneous order. These tests should be conducted on different lengths of line and the percentages of errors calculated and plotted as previously described. Finally, a comparison of the general test, and tests for loudness and articulation showing the net result of all three, will give quite acurate ideas of relative excellence.

Methods of Signaling and Operating in Telephone Exchanges.—V.

BY KEMPSTER B. MILLER AND CHARLES S. WINSTON.

WESTERN ELECTRIC TOLL SYSTEMS.

THE systems for handling toll business installed by the Western Electric Company are numerous, and differ as widely as the methods it has employed in handling most other branches of telephone service. However, during the period beginning at about the time when the common battery multiple switchboard came into general use and ending about two years ago, two methods stand out conspicuously from the others, as they have been used in many large installations with generally better results. While these two systems were similar in operation and in the results accomplished, they differ materially in many respects.

In each of these systems the connecting links between the toll board and the common battery board are made by means of toll trunk circuits. These circuits end in plugs and lamps at one or more toll-switching positions on the local multiple board, and appear at the toll board in lamps and keys at a recording operator's position, and in jacks multipled through the toll line sections.

These two systems, which will be designated for convenience as "A" and "B," differ mainly in that one of them, system "A," only two wires are used in each trunk circuit extending between the toll board and the local multiple board, while in the other, system "B," three wires are required for the same purpose. Of course, where the toll and local boards are located in the same building, the cost of installing and maintaining three wires for each toll trunk circuit instead of two is of comparatively little moment, and is to be tolerated, if, by doing so, any material reduction in the complexity of the apparatus or gain in the method of operation is to be effected. Where, however, the toll board is located at a considerable distance from the local board or boards, as is usually the case in large cities, the use of three wires for each toll trunk circuit becomes a serious matter, and is generally avoided.

System "A" probably owes its existence to this difference more than to any other one thing.

In neither system are cord circuits provided at the recording operators' positions, as keys, in the toll trunk circuits, which are located in the face of the board, furnish means for doing all of the work required.

The clearing-out drop ordinarily used in the cord circuits in both systems is an electrically restoring drop of the well-known Western Electric type, which is restored whenever the operator throws the listening key which is connected with the corresponding cord circuit. Each of these drops is wired through an additional key so that it may be cut out of circuit in case of a very long-distance connection over which talking is difficult, in which the bridge afforded by the drop across the circuit might interfere with the transmission.

WESTERN ELECTRIC TOLL SYSTEM "A," USING TWO WIRES IN TOLL TRUNK CIRCUITS.

In this system, which is the one used until recently by the Bell Companies in cities where the toll board was at a considerable distance from the local board, a repeating coil is located in each toll trunk circuit, and on this account the toll switching operator at the local board rings the bells of common battery subscribers for whom long-distance calls are received. The cord circuits used by the toll operators in establishing connections between toll and common battery subscribers are the same as those used in making toll-to-toll connections. In order to inform the toll-switching operator at the local board when the subscriber whom she has been ringing answers, a ringing lamp is provided in connection with each toll trunk plug at the toll switching position; and in order to give this operator a signal for taking down the connection, a disconnect lamp also is associated with each of the trunk plugs at her position.

The operation of this system is as follows, reference being made to Fig. 9. A common battery or local subscriber desiring to converse with a toll subscriber will signal his operator in the ordinary manner, and on the response of the operator will ask for "long distance." The operator will then speak over an order wire to a toll switching operator at the local board, and tell her that a certain subscriber desires a toll connection. The toll trunk operator will then insert a toll trunk plug which is not in use into the multiple jack of that line, and the subscriber's operator will remove the answering plug from the answering jack of the subscriber's line. The act on the part of the toll trunk operator of inserting the toll trunk plug into the multiple jack will, since the subscriber of that line has his receiver off the hook, light a lamp with a white cap, located in the face of the toll board at the recording operator's position. The lighting of this lamp corresponding to any toll trunk line is therefore dependent, first, on the toll trunk operator having made a connection between the end of that line and the line of a subscriber; second, on that subscriber having his receiver off the hook. The recording operator, in response to this signal, will throw the listening key associated with

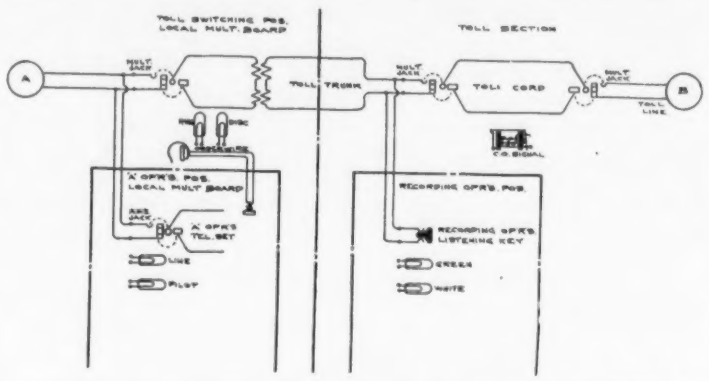


FIG. 9.—SHOWING CONNECTION OF LOCAL TO TOLL SUBSCRIBERS. WESTERN ELECTRIC "A."

this lamp and located directly below it. This act will extinguish the white lamp and light in its place a green one. It will also connect the operator's telephone circuit to the toll trunk line, and therefore enable her to communicate over it with the subscriber. She is thus enabled to make out a ticket containing the proper data for the toll connection, and will pass it on to one of the toll line operators. Having done this she will restore her listening key, but in doing so she will not extinguish the green lamp, as it remains lighted until the toll operator in taking up the connection inserts a plug into the multiple jack of the toll trunk line.

The purpose in furnishing two lamps at the recording operator's position is to make it impossible for the recording operator, after she has answered the call and before the toll operator has taken up the connection, to forget that she has already responded to the signal of the white lamp, and again speak to the subscriber. If one lamp only were furnished, it would be necessary to arrange it so that it would relight when the recording operator threw the listening key back to its normal position; in order to enable the subscriber to signal while waiting for the toll operator to respond.

The toll line operator having received a ticket from the recording operator, will insert the answering plug of a toll cord into a multiple jack of the toll trunk line. This, as before stated, will extinguish the green lamp at the recording operator's position. She will then insert the calling plug into the multiple jack of the desired line, and thus, after ringing, bring the two subscribers together for conversation.

At the end of the conversation the clearing out signal will be received at the toll board by the falling of the drop in the toll cord circuit. Having received the clearing-out signal, the toll operator will remove the calling and answering plugs from the toll line jack and the toll trunk jack, respectively. The act of withdrawing the answering plug from the trunk jack will light the disconnect lamp at the toll trunk position, and the toll trunk operator will remove the plug from the multiple jack. The act of taking down the connection at both the toll position and the toll switching position has no effect upon the signals at the recording operator's position, that operator having finished all duties in regard to the connection when she passed the ticket to the toll operator.

When a toll subscriber desires to converse with a multiple board subscriber, he will signal the toll line operator in the regular manner by throwing down the line drop at the toll board. Of course, this may be done by the toll operator at a distant exchange. The toll operator will then insert an answering plug into the toll line jack, and after throwing the listening key to find out the number of the common battery line with which the connection is to be established, she will speak over an order wire to the toll trunk operator telling her that a toll connection is to be established with a certain common battery line. The toll trunk operator will designate the trunk for use in es-

tablishing the connection, and with the plug of this trunk will test the jack of that line. In case the line is busy, she will insert the trunk plug into a busy back jack which will notify the toll operator by "tone" that the line is busy. In case the line is free, she will insert the trunk plug into the multiple jack. The ringing lamp associated with the trunk plug at the toll trunk position will light immediately, and the toll trunk operator will ring the subscriber. When the subscriber answers the call, this ringing lamp goes out and cannot be relighted without first withdrawing the trunk plug from the jack. This connection is shown in Fig. 10.

At the end of conversation the toll line operator receives the disconnect signal in the same manner as at the end of a local to toll connection, and upon withdrawing the toll trunk plug from the toll trunk jack, lights the disconnect signal at the toll switching position on the multiple board, in the same manner.

The recording operator has nothing to do with establishing a connection from a toll to a local subscriber. In this case the toll line operator does all of the work at the toll board and makes out the ticket without the help of any other operator. Thus, it will be seen, that unless the charge is to be "reversed" the recording operator

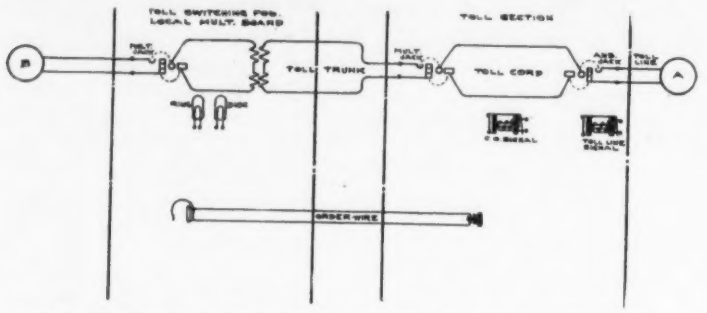


FIG. 10.—SHOWING CONNECTION OF TOLL TO LOCAL SUBSCRIBERS. WESTERN ELECTRIC "A."

always makes out the ticket when the charge is to be made against a common battery line, and the toll line operator when the toll station is to be charged for the connection. This is a guard against making mistakes and charging the wrong party for the conversation. If for any reason after a common battery subscriber has called for a toll connection and the switching operator has inserted a trunk plug into the multiple jack of the calling line and thus lighted the lamp at the recording operator's position, the recording operator does not desire to have the connection made, she will press a push button key associated with the toll trunk line in use, thus extinguishing the lamp at the recording operator's position and lighting the disconnect lamp at the toll switching operator's position.

WESTERN ELECTRIC TOLL SYSTEM B, USING THREE WIRES IN TOLL TRUNK CIRCUIT.

In this system the repeating coil, instead of being included in the trunk line circuit, as in system A, is included in the cord circuit at the toll board. One-half of each of these cord circuits is wired the same as half of a cord circuit at the local multiple board, the other half being wired, as in ordinary magneto practice, the clearing-out drop being bridged across the two strands of the cord. Each cord circuit is equipped with a key which is so wired that when thrown the repeating coil is cut out of the circuit and a straight circuit established between the two plugs so that the same pair of plugs can be used for establishing toll-to-toll connections, as is used for establishing toll to local connections, the only difference being in the position of the repeating coil key.

In this system a disconnect lamp but no ringing lamp appears in connection with the plug of each toll trunk circuit at the multiple switchboard end, but the toll trunk circuit contains no repeating coil, and therefore the toll line operators ring the bells of the local subscribers over these lines instead of having the toll trunk operator do this, as in system A. This is, of course, a better arrangement, and enables the toll operator to be the true master of the situation and to more properly supervise a call than where the toll trunk operator is compelled to do the ringing.

This system has not, to our knowledge, been used except in cases where the toll sections and multiple switchboard are located in the same building.

The operation of establishing a connection between a local and a toll subscriber is exactly the same in this as in Western Electric system A. The parts involved in such a connection are represented in Fig. 11, it being seen that the services of the subscriber's operator, the toll switching operator, the recording operator and the toll operator are all required.

At the end of the conversation a double clearing-out signal will be received at the toll board. The toll subscriber will, by turning his generator crank, throw the clearing-out drop, and, the local subscriber, by hanging up his receiver, will light the supervisory lamp associated with the local side of the toll cord circuit. The toll operator will then throw her listening key so as to restore the clearing-out drop, and listen in to satisfy herself that some one at the toll station does not desire another connection. She will then withdraw the plugs from the toll trunk and toll line jacks. The act of withdrawing the plug from the trunk jack will automatically light the disconnect signal at the switching operator's position on the local multiple board, and this operator will remove the trunk plug from the multiple jack of the local subscriber.

A push-button key is provided at the recording operator's position in connection with each toll trunk circuit, wired so that the recording operator can give the disconnect signal at the multiple switchboard, and extinguish the lamp associated with the trunk line at her own position in case she does not desire to have the connection established.

A toll to local connection is established in practically the same manner as in system A, the toll operator ordering up the connection at the toll switching position by order wire. As in that system, the A operator and the recording operator play no part in a toll to local connection. In this, however, the toll operator, instead of the toll switching operator, rings the local subscriber.

The method of making connections between toll subscribers in these two systems, A and B, is almost identical. In both cases a toll subscriber signals the toll board by turning the generator crank and thus throwing the line drop at the toll board. The operator will insert an answering plug, and after throwing her listening key, speak to the subscriber and find out that a connection is desired with some other toll station. In system A, the cord circuit can be used for making either a toll-to-toll or toll-to-local connection without change, but in system B the cord circuits are normally suited for making

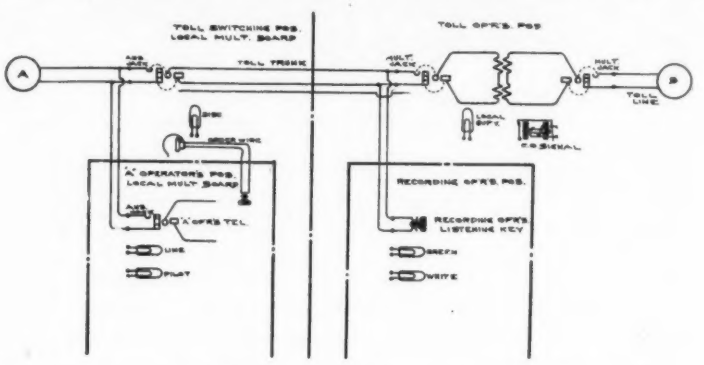


FIG. 11.—SHOWING CONNECTION OF LOCAL TO TOLL SUBSCRIBERS. WESTERN ELECTRIC "B."

connections between toll and local subscribers. On this account it is necessary for the toll operator in system B to throw a key associated with the cord circuit before this cord circuit can be used for connecting two toll subscribers. Having done this the remainder of the operation is the same as in system A. After testing, the operator will insert the calling plug, associated with the answering plug in use, into the multiple jack of the desired line, and ring. Until the subscriber answers, it is necessary for the operator to listen in at short intervals so as to know when the call is answered. The operator who has charge of the calling toll line will make out a ticket and record on it the duration of the conversation, the number of the calling and the number of the called toll stations and the names of the calling and called parties.

Each of these two systems has advantages over the other. A costs less than B, not only on account of having two wires in the trunk circuits instead of three, but because the number of repeating coils is less when located in the trunk circuits than when located in the toll cord circuits. In system A the method of operation at the toll line positions is less complicated, as the same pair of cords is adaptable without change to either toll-to-toll or toll-to-local connections, and the operator is, therefore, required to make no change in her cord circuits. In system B it is necessary after a circuit has been

used for one class of service, for the operator to throw the repeating coil key before she can use the pair of cords for the other class of connections.

On the other hand, however, the second system enables the toll operator to properly supervise all toll connections, to ring up a common battery subscriber herself, and at the end of the conversation to receive a lamp disconnect signal directly from the common battery subscriber. This latter much facilitates the work of keeping track of the duration of conversation, as in this case there is no doubt in the mind of the toll operator, whose duty it is to measure the lapse of time, as to when the common battery subscriber is through talking.

New Telephone Patents.

METALLIC FRAME JACK STRIP.

Metallic frame jack strips are without doubt the present standard, and new types and variations of present ones are periodically appearing. The latest development in this line is a jack invented and patented by L. M. Ericsson, of Sweden. This jack is built up in rubber strips secured to a frame plate of sheet brass. The plate is slightly longer than the rubber strip and its projecting ends are designed to slide into slots in the jack stiles, so that the strip is thereby supported. The strip of jacks mounts from the front, being held against the stiles by cover plates, which hide the ends of the jack strips. The cover plates are in lengths equal to the width of five strips, and are secured by screws passing into the jack stiles.

DESK TELEPHONE STAND.

Another invention of Mr. Ericsson is a design for a desk telephone stand of a kind little used in this country. This stand is adapted for use with the hand microphone; that is, a transmitter and receiver mounted upon a handle so that when the former confronts the mouth the latter will be against the ear. Mr. Ericsson's stand is a four-legged metal frame from the top of which a sliding rod projects. The bottom of this contacts with springs which serve the purpose of the ordinary hook switch, while the top carries a cross bar with prongs adapted to receive the hand microphone. The action is almost obvious, the weight of the microphone of course throwing the circuit changer.

CASING FOR TELEPHONES.

In this connection it may be well to consider a patent covering a "Casing for Telephones," as this is designed for instruments of the hand microphone type. Fig. 1 shows a side view of the instrument.

FIG. 1.—HARDEGEN TELEPHONE CASING.

The chief novelty lies in a deparature from the time-honored means of securing receiver caps. The casing of the instrument is of punched metal with a flange left at the rim. The ear piece, of metal also, lies over this, being secured by semi-circular spring pieces which snap in behind the flange of the casing. Paul Hardegen, of Berlin, is the patentee of this instrument.

TRANSMITTER DISINFECTING DEVICE.

A new type of transmitter disinfecting device is that of C. Bravi-Bertini, of Perth Amboy, N. J. This consists of a sprayer in the transmitter fed with disinfectant solution from a small pump which is driven by a linkage secured to the switch hook.

TELEPHONE REPEATER.

The telephone repeater has received still further developments at the hands of Merritt Gally, of Brooklyn. Mr. Gally's earlier work in this direction has been noted in these columns and doubtless his type of repeater will be recalled. His latest work, which is covered by two patents recently issued, is along the same lines, dealing with a bipolar magnet form of his repeater and the circuit best suited to its operation.

RECEIVER SUPPORT.

Another receiver support has been patented. This time means are provided for the automatic return of the receiver to the hook. The receiver support may be deflected in a horizontal direction by the ear of the user and becomes locked in this position. This movement of the supporting arm switches the circuit to the talking condition. If the arm be not restored by the user, central may send a current over the line and through the agency of an electromagnet and release pin, the telephone is allowed to return to the normal position.

AUTOMATIC SYSTEM.

An automatic exchange apparatus, a modification of earlier work, has been jointly invented by Messrs. J. K. Norstrom and J. J. Brownrigg, of Chicago, the patent which they have obtained being assigned to the Globe Automatic Telephone Company. The most interesting feature of this new system lies in the busy test apparatus. This is a relay in series with the subscriber's instrument and located on his premises. In case a desired line is busy the circuits are such that the busy relay at the calling station opens the talking circuit of this station until such time as the receiver has been momentarily at least returned to the switch hook and the switching devices thereby returned to the zero position.

ANOTHER CABLE SUPPORTING CLIP.

This week we have again for consideration a cable supporting clip. This is clearly shown in Fig. 2. It comprises the now usual zinc

FIG. 2.—VILLARD AND COPELAND CABLE HANGER.

cable-encircling strip and a bent wire supporting hook. In this instance a double form of hook is used so shaped that not only is a locking of the tape about the cable obtained, but the weight of the cable serves to keep the tape tight. Messrs. R. H. Villard and H. P. Copeland, of Jersey City, are the joint inventors of this clip.

A Memorial to James Watt.

A most interesting and laudable movement has just been set on foot by Mr. Andrew Carnegie—ever foremost in good works—namely, to erect a memorial statue at Greenock, Scotland, on the site of the humble cottage in which James Watt, creator of the steam era, was born. The American Committee of the James Watt Memorial has Mr. Carnegie as its chairman and Mr. Theodore Dwight as its secretary and treasurer, with offices at 99 John Street, New York City. The circular just issued states that for the object named: "Subscriptions of small amounts are being solicited in many countries, as it is felt that the memorial should represent the contributions of the thousands who know and appreciate what the invention of the steam engine has meant to the material progress of the world. Should you desire to associate yourself with this movement, kindly send five dollars, or less, and accompany the contribution with your autograph on the enclosed slip. The later is desired for transmission to Greenock to show the number of the American contributions. Our country has, probably, been the greatest beneficiary of Watt's labors, and the committee hopes that the response from the United States will exceed that of any other country in point of numbers, as the number of subscribers is a greater tribute than the amount subscribed."

A great deal of interest is being taken in the project here and the committee formed under Mr. Carnegie comprises Albert R. Ledoux, president American Institute of Mining Engineers; Ambrose Swasey, president American Society of Mechanical Engineers; Charles Hermany, president American Society of Civil Engineers; Bion J. Arnold, president American Institute of Electrical Engineers; Chas. F. Scott, Westinghouse Electric Manufacturing Company; John H. Converse, president Baldwin Locomotive Works; Charles Allis, past president Allis-Chalmers Company; Charles Wallace Hunt, president C. W. Hunt & Co.; S. R. Calloway, president American Locomotive Company; R. A. McKee, International Union Steam Engineers; John C. Kafer, Engineers' Club, New York; J. D. Farasey, American Boiler Manufacturing Association; C. L. Salmons, Brotherhood of Locomotive Engineers; J. J. Hannahan, Brotherhood of Locomotive Firemen; W. J. Gitthorpe, Boilermakers and Iron Shipbuilders of America; C. L. Shamp, International Brotherhood of Stationary Firemen.

Indiana Independent Toll Line Association.

Several independent telephone men from northern Indiana and southern Michigan held a meeting in South Bend, Ind., on February 27 and organized the Northern Indiana and Southern Michigan Toll Line Association. The delegates represented a territory in which there are 15,000 independent telephones and 2,000 or more miles of toll lines. That city has been chosen as headquarters for the clearing house. The officers are: Theodore Tharward, manager of the clearing house; J. K. Johnson, secretary and treasurer. C. A. Reeves, J. S. Scott and C. R. Stoops and the officers compose the traffic committee which will perfect plans. The cities in the combination and the number of telephones in operation are: South Bend, 520; Elkhart and Goshen, 1,742; Michigan City, 750; Knox and Hamlet, 200; Winamac and Kewanna, 350; Makarusa, 175; Millersburg, 785; Dunlap, 150; Warsaw, 400; Plymouth, 300; Rochester, 430; Bremen, 136; Nappanee, 275; Millford, 276; Columbia City, 900; Silver Lake, 125; Star Point, 200; Argus, 65; North Judson, 50; Teegarden, 105; Bristol, 100; Lagrange, 1,600, and Benton Harbor, Mich., 1,575.

CURRENT NEWS AND NOTES.

HIGH TENSION MEETING IN CHICAGO.—The Chicago branch of the American Institute of Electrical Engineers will hold a meeting March 18 to discuss the subject of high-voltage lines.

CANAL TOWING.—A bill has been introduced in the New York Legislature providing that no permit to conduct electric towing experiments shall be granted by Superintendent Boyd for a stretch of canal over five miles long or for a period exceeding three years.

OPENINGS IN JAVA.—Mr. B. S. Rairden, of Batavia, Java, writes: "I believe there is a good opportunity for some enterprising American company interested in electrical material to make good connections here, although it must be prepared to fight German competitors, who are, I am so informed, largely interested in the electrical companies established in Batavia, etc."

TESTING OYSTERS FOR PEARLS.—A new use for the Roentgen rays is announced from Paris. M. Dubois has just read a paper before the Academy of Sciences, which shows that it is possible, by means of the Roentgen rays, to examine the living oyster, without in any way injuring it, and to ascertain whether or not it contains a pearl. If it contains only a tiny pearl the oyster is returned, and is allowed to live until the disease has sufficiently advanced.

ELECTRODE FOR ELECTROLYTIC PURPOSES.—A patent granted on March 1 to Mr. G. J. Atkins, of Tottenham, England, refers to details of construction of a carbon electrode. The current is introduced through a metallic sheet, which is covered by the carbon electrode. Since, however, carbon is always porous and the electrolyte would pass through the pores and attack the metal, the inventor interposes between the carbon and the metal a conducting but water-proof substratum made of finely divided carbon mixed with mineral lubricating oil.

CARBON RESISTANCE.—A patent granted on March 1 to Mr. G. I. Leonard, of Pasadena, Cal., refers to the construction of a plumbago resistance. A sheet of asbestos is coated on both faces with plumbago, applied in the state of a paint or paste with water and sufficient sugar to adhere to the support. The coating is made so thick that the resistance is somewhat higher than desired; after the plumbago is dried it is treated by frictional or rubbing pressure by a scraper or roller until the resistance is brought down to the desired value. The resistance is claimed to remain constant.

METHOD OF FORMATION OF STORAGE BATTERY PLATES.—In a patent granted on March 1 to Mr. O. Frank, of Detroit, Mich., the inventor proposes to treat the lead plates in an aqueous solution of 5 per cent. sodium sulphate and 0.7 per cent. potassium chlorate with a current of 1 amp. (the size of the plates being not given) for 50 hours at about 20° C. The plates are then washed in distilled water and the positive plates are placed in a weak solution of sulphuric acid and used as negatives against positives of lead, the current being "2 amp. for 50 hours." The plates are then washed and dried at a temperature of 300° C.

WIRELESS TELEGRAPH AND WEATHER.—The special correspondent of the New York *Times* cables as follows: "I will mention in this connection a memorial soon to be forwarded to Parliament by the fishermen of Mousehole and Newlyn, who want the weather changed and think the change can be brought about by act of Parliament. It is the candid and deliberate judgment of these fisherfolk that the Marconi wireless telegraph station located near them is the cause of the deluges that are descending on them. 'Take it away,' they say in their memorial to Parliament. Somebody will have to tell these poor petitioners that they are no worse off than the rest of Great Britain, for the whole country is watersoaked."

TAXING CANADIAN POWER.—Assemblyman Remsen, of Brooklyn, has introduced a measure in the New York Legislature which, if passed, he says, will produce $150,000 in revenue for the State. It puts a tariff of $2 on each electrical horse power produced in a foreign country and transmitted, sold or furnished to concerns in this State. It applies, of course, to Canadian concerns. There are a couple of power concerns at Niagara Falls, soon to be put in operation, which propose to furnish electricity for power in this State, and another at Cornwall on the St. Lawrence. Mr. Remsen proposes to tax them heavily. Failure to comply with the proposed law will subject any concern doing business in this State to a forfeiture of its charter and a fine of $100 a day.

A CURIE LECTURE.—Special correspondence to the *New York Times* from Paris of February 23 says: "M. Curie's promised lecture on radium drew vast crowds to the Sorbonne one evening this week. Although the hall in which the world-famed chemist was to speak is built to seat 3,000 persons, numbers who had stood for hours at the door in the Rue des Ecoles were finally turned away, every corner available being occupied by a deeply interested crowd. When the lecturer appeared upon the platform with Mme. Curie they received a magnificent ovation, and every word M. Curie spoke was followed with the closest attention. His account of the work done by M. Becquerel upon uranium, which formed the starting point for his own and Mme. Curie's experiments, was very clearly given, and his lecture was illustrated by tests of the properties of the newly discovered metal. In one series of experiments M. Curie demonstrated that radium emits three sorts of rays, two of which give off such powerful electric emanations that they cause phosphorescence and produce perpetual motion. Then, plunging a tube of radium into liquid air, M. Curie demonstrated in the darkness of the hall that it was a light-radiating body, and that it also gave out heat."

METER.—Four patents for details on electric meter construction were granted on February 23 to Mr. Thomas Duncan. In the first patent a construction is described by which an ordinary integrating meter is associated with a supplementing measuring mechanism which is operated by the main measuring mechanism. The meter with the main measuring mechanism may be located at a somewhat inaccessible place, while the supplementary measuring mechism is placed in a more convenient situation, for instance, in the library or office of the consumer. To allow recalibration, step-by-step adjusting means are provided in combination with supplementary field windings for effecting additive or counteracting torque. The second patent relates to motor-meters, suitable to be used on circuits of different voltages. This is effected by using an auxiliary field winding of which more or less may be switched into the circuit. He also describes details of construction by which he is enabled to polish readily the commutators and brushes of commutator-motor meters, without disturbing the tension adjustment of the brushes. The third patent relates also to details of construction of motor-meters and refers especially to the construction of the spindle bearing point, the manufacture of the spindle in three parts, and the construction of the upper bearing. The fourth patent again refers to the construction of the bearings. In order to render the jewel posts incapable of assuming any except predetermined positions with the meter bases, he relieves the posts of any threaded engagement with the remainder of the meter structures.

IOWA ELECTRICAL ASSOCIATION.—The Iowa Electrical Association will hold its convention this year at Des Moines, Iowa, April 13 and 14. W. S. Porter, of Eldora, is secretary.

VERMONT ELECTRICAL ASSOCIATION.—The annual meeting of the Vermont Electrical Association was held at Rutland on February 24, about 40 members being present. At the evening session Mr. F. J. Vaughn gave an address on "Central Station Meters." There was a display of electrical supplies. The officers elected for the ensuing year are: President, M. Patterson, of Fair Haven; first vice-president, E. D. Blackwell, of Brandon; second vice-president, E. E. Gage, of St. Johnsbury; secretary and treasurer, C. C. Wells, of Middlebury; chairman of executive committee, Frank Barney, Jr., of Springfield.

RADIUM IN TEXAS.—With regard to the recent reports of the discovery of radium-producing minerals in Texas, a correspondent in that State writes that the Nernst Lamp Company is mining rare earths in the locality known as Barringer Hill, which is situated 11 miles from Kingsland, Tex. This region yields gadolinite and five other new and rare minerals. The mining of yttria ore on a large scale, it is stated, gave rise to the reports that radium was being sought. It is stated that the Nernst Lamp Company is trying to purchase more land containing the earths and minerals which it utilizes in the manufacture of its lamps, but the owners have raised the prices to almost prohibitive figures. It is asserted by representatives of the lamp company that the gadolinite which it is mining does not contain radium or radioactive properties. The landowners say, however, that this statement does not agree with the reports of disinterested scientists who have recently conducted tests and examinations of the mineral. These assert that the earths possess a greater amount of radioactive properties than those of any other known region in the world.

SELECTIVE SIGNALING IN WIRELESS TELEGRAPHY.—Two patents were granted on February 23 to Prof. Reginald A. Fessenden. The first relates to a new method of tuning the sending and receiving stations to the same frequency. Electric tuning is efficient, but requires a great deal of care in its operation. Prof. Fessenden prefers, therefore, mechanical tuning. His method is essentially as follows: At the transmitting station electromagnetic waves are generated with a certain predetermined frequency—say, 2,000,000 per second—in groups of a lower frequency—say, 126 per second. For this purpose an induction coil with spark-gap may be used in connection with a make-and-break mechanism for the induction coil actuated by a tuning fork operative at the group frequency of 126 periods per second. At the receiving station the wave-responding device is connected to an indicating mechanism responding only to the group frequency 126. Such a device may consist of an electrically-operated tuning fork torque attached to a telephone tuned to the group frequency 126. Thus, unless the tuning fork or telephone at the receiving station is tuned to the frequency 126, no indications or signals will be produced. Of course, different modifications of this method and combinations are quite feasible. The second patent granted to Prof. Fessenden relates to a device for preventing disturbances from another station in the neighborhood, so that stations may be worked simultaneously while situated close to each other. For this purpose he provides, besides the main conductor of the system, second or auxiliary conductors. They are so proportioned that the effect on the main conductor, of waves emitted from the disturbing station, will be opposed and neutralized by the effect of the disturbing waves upon the auxiliary conductor.

LETTERS TO THE EDITORS.

Alternating Current Commutating Motors.

To the Editors of Electrical World and Engineer:

SIRS:—The question of priority of invention raised by the letter published on page 327 of the ELECTRICAL WORLD AND ENGINEER of February 13 should be considered from the two following points of view: 1st, validity of my patents; 2d, scientific discoveries involved.

Referring to the first point of view, I do not need to show in these columns the novelty of the dispositions described in my United States patent applications, since this matter is to be decided by the United States Patent Office.

Referring to the second point of view, the old United States patent, 476,346, evidently does not concern in any manner the phenomena which I have recently discovered and pointed out, and which alone form the basis of the conception of my series compensated motor as described in several publications. Those phenomena are: (*a*) The disappearance of self-induction in an armature with commutator and short-circuited brushes when running in the vicinity of synchronous speed. (*b*) The induction by such an armature of a rotary field at synchronous speed, if it is revolved in a stator without any magnetic axis of symmetry. (*c*) Perfect commutation at brushes under the above conditions; and, furthermore, (*d*) The screening effect of short-circuited brushes for the ampere-turns of the stator in which the armature is revolved.

The last paragraph of my letter published in your issue of March 5 may lead to a misunderstanding. In fact, the power factor of a repulsion motor is, *for the same air-gap*, much greater than that of a single-phase induction motor. The formula which I have published on the subject of the repulsion motor (*Elektrotechnische Zeitschrift*, 11 June, 1903) proves that the magnetizing current taken by a repulsion motor without load amounts to only half of the current taken by the corresponding single-phase induction motor. (The current corresponding to a zero load in a repulsion motor is obtained by making $\Theta = 0$ in my formula, giving the current taken by the motor at synchronous speed.)

But as a motor for tractive purposes must have a considerable air-gap, the power factor of a repulsion motor for traction approaches that of an ordinary single-phase induction motor.

It is only by using low frequencies, as I have pointed out in the German article above referred to, that it is possible to obtain $\tan \phi = \frac{1}{2}$; that is, $\cos \phi = 0.895$.

NEW YORK. MARIUS LATOUR.

Thawing Out Water Pipes Electrically.

To the Editors of Electrical World and Engineer:

SIRS:—Seeing an article in the February 13 number of your paper, I take the liberty to call your attention to the fact that Mr. Greene, of Altoona, Pa., gives the credit of thawing out water pipes electrically to Messrs. Jackson and Wood. I wish to state that the scheme originated with Frank H. Soden, of Chicago, in the winter of 1898. It was over a year, I believe, before Prof. D. C. Jackson, of the University of Wisconsin, came out with articles claiming that he was the one who first worked it out successfully, and originated the scheme. Furthermore, at the time Mr. Soden hit on his scheme and made it work he applied for a patent, but the Commissioner of Patents would not grant him one, claiming it was too simple.

At the time Mr. Soden demonstrated the practical use of thawing out water pipes by electricity, all of the daily and electrical papers in Chicago had great accounts of it, showing cuts and describing it at length. He had to go to nearly all of the managers of power plants in Chicago to ask permission to try his scheme. They all laughed at him except the Commonwealth Electric Company, on the South Side. It was there he demonstrated the feasibility of thawing out frozen water pipes by electricity.

Mr. Soden is a man of great ability, and was one of the earliest engineers with the old Thomson-Houston Company. He is at present at Pony, Mont., with an electrical process of treating ore, for which the Pony Electric Light Company, of which I am manager, is furnishing him all the current needed gratis, as well as a stamp mill.

PONY, MONT. E. R. AVERY.

Carbon Resistances.

To the Editors of Electrical World and Engineer:

SIRS:—Your issue of February 20 contains in the Digest news, under the heading, "Units, Measurements and Instruments," "Carbon Resistance, Gray," a description of a high resistance made by depositing soot on a glass plate or some other insulating surface. Johnson & Phillips, of Charlton, England, used to make just such resistance when I was a pupil with them away back in 1879. I believe they stopped manufacture, because the soot so deposited had a tendency to crack whenever the glass expanded and so make an open circuit. I think the Nalders, also of England, make a similar kind, but their

resistance is set to 1,000,000 ohms, or whatever is required, while the older ones were kept to whatever they measured at first.

Curiously, only last month while I was down in Philadelphia, I suggested the same thing to a foreman of an electric construction company, who wanted a cheap high resistance, to make tests for insulation on completed lines.

WILKESBARRE, PA. E. W. STEVENSON.

Individual Motor Drive.

To the Editors of Electrical World and Engineer:

SIRS:—Your issue of February 20 contains in the Digest of Current Electrical Literature an abstract from an article by Cooper on "Individual Motor Drive," published in full in the current number of *Cassier's,* and also essentially in your convention issue of last June 6. That part of the article covered by the abstract treats essentially of certain rules and deductions laid down by Mr. Cooper for determining the proper size of motor to use in accordance with the methods of speed control adopted. These rules are based primarily upon a certain assumption of Mr. Cooper's, with which many electrical engineers cannot agree. Mr. Cooper's rules, moreover, are being broadly published as established facts by numerous technical and engineering publications. It would appear proper, therefore, to have the leading publication of electrical engineering discuss this article and put the same in a clearer light before the public. If it can be shown that Mr. Cooper's premises upon which he bases his deductions are wrong, or at least not fully proved, his rules will fall to the ground.

In discussing the effect of weakening the field of a motor, Mr. Cooper states as follows: "If it is desired to increase the speed 100 per cent. by field weakening, one must have 100 per cent. margin for sparking at normal speed if the motor is to carry full load at the increased speed." He then jumps to the conclusion, without giving the slightest reason, that in order to obtain this necessary 100 per cent. margin for sparking it is absolutely necessary to double the size of the motor. Nobody will disagree with Mr. Cooper that this method will accomplish effectually the elimination of sparking, and that it is a most excellent one to adopt by those who look with disfavor upon the variable field method of speed control. But is this fair? Is it good engineering or necessary to go to such extremes as this? It is right on this assumption that proof is asked for and found wanting.

Let us get clearly before us what causes sparking with a weakened field, and see if we can find any logical reason for Mr. Cooper's bold jump to conclusions. The magnetic field, due to field winding, and the magnetic field, due to armature winding, make an angle with each other, and the position of the resultant field created thereby shifts relatively in accordance with the relative magnetic strength of the field and armature. If the field magnetism is weakened, the armature magnetism remaining the same, the resultant field will tend to approach more nearly the direction of the field produced by the armature winding when acting alone. This tends to produce sparking by retarding the neutral position back of the brushes. The converse is also true that when a motor is running under light load with full field, the resultant field will then advance towards the direction of the field produced by the field winding when acting alone. This condition also tends to produce sparking at the commutator by moving the neutral point ahead of the brushes. Sparking under this condition is not noticeable, however, chiefly because the quantity of current flowing is small. The destructiveness of a spark is measured by the product of the current into the electromotive force producing it.

Sparking on the commutator is caused by cutting in and out of the line circuit each one of the coils on the armature, as its commutator segments pass under and out from the brushes. The commutator segments connected to each armature coil cause the coil to become short-circuited on itself when its segments pass under the brushes. Each coil will consequently at that time have generated in it an electromotive force which will cause current to flow through the coil in a direction determined by the relative position of the resultant field set up by the combined effect of the field and armature windings. If the armature winding predominates, the current will flow in the short-circuited armature coils in the opposite direction to that of the applied current taken from the lines. If the field winding predominates, the current will flow in the same direction as the line current, and if both windings are such as to bring the coil into the neutral field when said coil is short-circuited by the brushes, no electromotive force will be induced and no current will flow in the coil. It is only under the first conditions, however, that sparking is reduced to a minimum, namely, when current is actually caused to flow in the coil in the opposite direction to that of the line current. When the segments pass from under the brushes, current will then be flowing in the same direction as the line current, since this reverses in every coil as it passes from under the brushes. If this current, therefore, had not been previously created in the coil, its self-induction would resist instantaneous reversal, and the current would largely shunt directly across the segments and produce destructive sparking. This condition, of course, would be still further aggravated if current was caused to flow in the short-circuited coils in the same direction as the line current before the segments of the coils pass from under the brushes. Sparking is still further effected by hysteresis, or the lagging behind of the reversals of magnetism in the armature discs. It is apparent that the effect of hysteresis will increase directly with the armature speed. It seems possible, however, to take advantage of this increased hysteresis at the higher speeds and utilize it to assist in offsetting the effect of a weakened field in increasing the tendency to spark. The effect of weakening the field is to increase the speed and also to allow the armature winding to pull the resultant field back of the non-sparking position of the brushes, while the effect of hysteresis, as the speed increases thereby, is to cause the reversal of magnetism to lag behind, and thus, to a certain degree, counteract the effect of the increased tendency to spark caused by the relatively predominating influence of the armature windings, thus preventing the inducing of too great a current in the short-circuited coils, which otherwise would produce sparking. In a proper design, then, the above two causes which tend to shift the sparking point of the brushes may be so nicely balanced as to allow a very large variation of speed by field weakening. Of course, there are many other details of design to be carefully worked out, and the above theory is merely set forth to show that even the usual theoretical conception of the cause of sparking under variable field conditions is not so difficult of a practical solution as might otherwise appear.

Mr. Cooper goes on to say "that the limit of power of a motor operating under full field strength is the heating effect of the current flowing through the armature, but the limit of power of a motor with a weakened field is the sparking at the commutator." With the cause of sparking clearly before us, it would seem as though these two statements contradict each other. Abnormal currents in the armature produce a similar distortion of field as results from weakening the field magnetism, and the resultant sparking is far more destructive on account of the relatively larger currents producing them. Well-designed motors will not spark seriously at their commutators when carrying double their normal load at full field strength, and their limit of power, as Mr. Cooper states, is the heating effect of the armature current. Such motors practically have a 100 per cent. margin for sparking. Why is it not then perfectly practical to build motors that will develop their full rated horse-power at double their normal speed, with a weakened field, without undue sparking? The current producing the sparking in the latter case is only half as great as in the first, and the cause of the tendency to spark is, perhaps, no greater in one case than in the other.

Theoretically speaking, weakening the field of a motor merely weakens its torque or turning effort, and as the speed increases in direct proportion as the decrease in torque, the horse-power capacity of the motor remains constant within reasonable limits of field weakening. It is certainly true of a great many makes of motors now on the market that they will actually develop the same horse-power at double their normal speed with weakened field, but most of them will spark badly at the commutator on the higher speeds when transmitting their rated horse-power, simply because they were designed to run at a constant speed. It is true, however, that motors can now be purchased that will develop their full rated horse-power over a speed range of 4 to 1 by field weakening, without abnormal sparking, over this entire range of speed. A quotation was received a few days ago from one of the large motor manufacturers for furnishing a suitable frame capable of developing 15 hp at 900 r.p.m. under full field strength, but so wound specially that it would develop 5 hp at 300 r.p.m. with full field and 5 hp at 1,200 r.p.m. with weakened field, without undue sparking at the commutator. This manufacturer consequently starts with a slow-speed motor, capable

of developing 5 hp *only* at 300 r.p.m., and makes this motor continue to deliver 5 hp at any speed up to 1,200 r.p.m., without injurious sparking at the commutator.

Mr. Cooper's rule for determining the size of a motor to fill the above specifications reads as follows: "The relative size of motor, as referred to the maximum speed, is as the square of the speed variation when using field regulation." This means that if a 5-hp motor is capable of developing sufficient horse-power at its maximum speed of 1,200 r.p.m. under full field strengh, it will be necessary to employ a size of frame equal to 5 multiplied by 4 square, or 80 hp, in order to develop satisfactorily 5 hp of work over the entire range of speed from 300 to 1,200 r.p.m. That is to say, under Mr. Cooper's rule it would be necessary to use a motor of four times the size as the one guaranteed to do this work in the quotation cited above. Whether or not Mr. Cooper's deductions are practically correct depends entirely, then, upon *who builds the motor.*

In the light of the above statements of theory and fact Mr. Cooper's rules for determining the size of motors are apparently limited to an attempt to obtain a variable speed from a motor distinctly designed to operate at a constant speed.

If motor users will take the trouble to purchase motors designed to operate at variable speed under variable field strength, guaranteed not to spark under full load conditions, at all speeds, Mr. Cooper's rules will be found entirely inapplicable, and the following may be substituted in their place:

(1) The total range of speed using both variable voltage and field regulation will be directly proportional to the range of voltages multiplied by the increase due to field weakening.

(2) The change of horse-power capacity will be directly proportional to the change of voltage on the armature.

(3) The horse-power capacity under variable field strength will remain constant.

(4) The relative size of motor as referred to the maximum speed will be directly proportional to its speed variation when using variable voltages.

(5) The relative size of motor as referred to the maximum speed will be directly proportional to its speed variation when using field regulation.

(6) The size of motor required to develop a constant horse-power over the entire range of speed is *identical,* whether the multiple voltage or weakened field system be used, or any combination of the two.

MILWAUKEE, WIS. H. H. CUTLER.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Voltage Regulation in Alternating-Current Systems.—MEYER.—The first part of a paper read before the Liverpool Engineering Society. He discusses the inherent regulation of generators which is usually defined as the percentage increase in the terminal voltage when full load is taken off the machine, the excitation remaining unaltered, and due allowance being made for variations in speed as caused by the engine regulation. In England sometimes another definition is used, namely, the percentage fall in voltage upon throwing on full load, keeping speed and no-load excitation constant. This definition, however, leads to entirely different figures and should be abandoned. To get close regulation of a machine the ratio of field ampere-turns to armature ampere-turns should be as large as is possible with an economic design. A low armature self-induction is useful by reducing the inductive drop in the armature conductors. For this purpose the winding has to be properly subdivided and so arranged that at the same time the effect of the end connections is minimized, which is of particular importance in machines with a large pole pitch and a small width. The leakage between poles should be as small as possible. For this purpose one has to choose short poles, a large pole pitch and the pole arc in maximum 66 per cent. of the pitch, although these requirements lead to a larger diameter and consequently to a more expensive design. The leakage coefficient is further covered by the length of the air-gap and the iron densities in the machine and increases with the load in about the same proportion as the excitation. The magnetic densities in the poles should be high, so as to introduce a saturated part in the magnetic bath, which will limit the rise in voltage when the load is taken off the machine. Densities of 110,000 to 115,000 lines per square inch are here quite allowable, provided the designer knows exactly the leakage coefficient of his machine and the quality of his material. It is advisable to differentiate between machines which are intended to work on unity power factor or on a power factor, say, not below 0.90, and those intended to work chiefly on a low power factor. In the latter case it is better to use lower densities than mentioned above, although this leads to a more costly design. Finally all parts in the machine should be so proportioned that the resultant wave shape of e.m.f. and current resembles as closely as possible a sine wave. Some of these points are illustrated by the author by means of diagrams and tables. Not only the size and cost of alternators are unfavorably influenced by too close a regulation, but the efficiency and stability of regulation are equally affected. A reduction in efficiency from 1 to 1½ per cent. may be expected when changing the machine with an inherent regulation of say 7 per cent. into one with 4 per cent. without resorting to saturation. In regard to stability of operation it is noted that very close regulating machines—due to their low armature reaction and self-induction—have a large short-circuiting current. With close regulating machines working in parallel large cross currents and a considerable exchange of energy between the bus-bars and the generators take place if the cyclic irregularity inherent to all reciprocating engines is not kept to a very small amount by means of an extra large fly-wheel effect, which, of course, increases the cost of the plant. But even then troubles in parallel may readily occur with too close regulating machines due to the natural period of the alternator becoming such as to introduce the danger of resonance with the forced oscillations of the engine. Large currents on short-circuit also tend to cause troubles in plants as required for rolling mills and mining works, where, due to the rough service, heavy overloads and even short-circuits may frequently occur. While within the above discussed limits a close regulation should be aimed at in all normal machines, there are also cases where a poor regulation is essential. This refers to alternators for constant power or constant current work, as required for certain electrolytic processes where the current is used for feeding an arc.—Lond. *Elec.,* February 19.

Sparking Dynamo.—BROWNE.—An account, from the records of an electrolytic refinery, of the troubles experienced for several weeks with a sparking dynamo. It was afterwards traced to the fact that several of the electrolytic tanks had been cut off since they were not properly working. This changed the total line voltage with a resulting weakening of the magnetic field and consequent sparking at the commutator. A diagram is given of a switch by which four different methods of field excitation are possible; self-excitated series and multiple field and separately excited series and multiple field, so that under all conditions of operation the field of the dynamo may always receive the proper exciting current.—*Electrochem. Ind.,* March.

REFERENCES.

Asymmetric Attraction of the Rotor in an Induction Motor.—REY.—The author first gives the theory of the subject and develops a formula for the attraction, which he then applies to a numerical case. His figures indicate that the asymmetric attraction may have important consequences. In the case of motors running at considerable peripheral speeds such as those used for traction or for operating rotary engines, centrifugal pumps, etc., these efforts combined with the weight of the movable parts may create dangerous vibrations. It is necessary to take them into account in the calculation of the pieces, since absolute symmetry can scarcely be realized in practice and the wear and tear gradually introduces a certain eccentricity.—*L'Eclairage Elec.,* February 20.

Single-Phase Series Motor.—NEWBURY.—An article in which, by

the aid of diagrams, the author explains the operation of the alternating-current series motor. While in general it works on the same principles as the direct-current series motor, the following phenomena characterize the alternating-current motor; an e.m.f. generated in the armature winding by the alternating magnetic field, in addition to the e.m.f. generated by the rotation of the armature; a local current circulating in the armature coils short-circuited by the brushes due to the e.m.f. just mentioned; an iron loss occurring in the entire magnetic circuit, due to the alternating magnetic field; an active e.m.f. existing between the turns of the field coils, what may be called the counter e.m.f. of the field coils. The author gives the voltage diagram of the motor.—*Elec. Club Jour.*, February.

Single-Phase Commutator Motors.—BLANC.—An illustrated note supplementing the summary of various types of single-phase commutator motors, recently given by Osnos.—*Elek. Zeit.*, February 18.

Repulsion Motor.—OSNOS.—An article illustrated by diagrams in which the author develops a complete theory of the repulsion motors of Atkinson.—*Zeit. f. Elek.* (Vienna), February 14 and 21.

LIGHTS AND LIGHTING.

Arc Between Metallic Oxides.—STARK.—An account of experiments in which he found that under certain circumstances an arc is more easily established between metallic oxides than between the metals themselves. He uses a vacuum tube in which the main current passes between the anode and the cathode and produces the ordinary glow phenomena, while the secondary current passes between electrodes at right angles to the primary electrodes, and is extinguished as soon as the main current is interrupted. At a pressure of over 50 volts and a vacuum of less than 0.5 mm., the presence of a film of metallic oxide, or of a few fragments of it, facilitates the production of an arc between the secondary electrodes. The author gives the following explanation of this effect: The lines of electric force proceed straight from the anode to the cathode, but if the latter bears a fragment of metallic oxide, they curve round it and enter the cathode at some other point. Nevertheless, the positive ions, having acquired a certain amount of momentum, go straight on and impinge upon the oxide, thus increasing its temperature and causing it not only to conduct electricity, but to evolve electrons in large quantities. Wehnelt has already shown that metallic oxides project more electrons than pure metals at high temperatures, and hence the arc, which requires a liberal supply of electrons, is more easily formed at the oxide than at the pure metal. At atmospheric pressure the author obtained a small arc between a carbon anode and a cathode of thorium oxide at a pressure of 1,800 volts and with a current of 7 milliamperes. The anode remained quite dark.—*Phys. Zeit.*, February 1; abstracted in Lond. *Elec.*, February 19.

REFERENCE.

Arc Lamps Giving Illumination in a Certain Direction.—RICHTER.—An account of photometric measurements of arc lamps giving light in a certain direction. For this purpose the two carbons were placed with their axles parallel to each other, but in such a way that they did not form one straight line, the one axle being parallel to, but laterally displaced from the other.—*Elek. Zeit.*, February 4.

POWER.

Turbines for Low Falls.—STEIGER.—An abstract of a paper in which the author draws attention to the prejudice which exists against the utilization of water power with low falls, and which is traceable to many unsatisfactory installations of absolutely unsuitable turbines. The demands of the generation of electricity by water power, such as high speed, rapid regulation and concentration of large power in one unit, have influenced very considerably the art of building turbines. In the first place, the desire for high speeds has led to a more general adoption of radial-flow turbines of which the inward-flow is preferable, being the more efficient. An example of radial outward-flow turbines was cited, with the special reasons which had led to their adoption in one case of a relatively low fall and the manner in which a quite satisfactory efficiency had been obtained from this otherwise less efficient type. One new type, the cone turbine, was referred to as taking the place of the so-called "mixed-flow turbine," with a view to obtain a high speed under low falls, even for large units. With special regard to electrical requirements, reference was made to the arrangement of several wheels on one common turbine shaft, vertical or horizontal, giving a few instances of the vertical arrangement which, in certain circumstances, was particularly advantageous, as the weight revolving on the footstep could be entirely balanced, and so the loss of power by friction was reduced almost to nil. The necessity of placing the footstep of a turbine in an accessible position was alluded to.—Lond. *Elec.*, February 19.

Electric Power for Rolling Mills.—KÖTTGEN.—A long paper read before the Society of German Iron Metallurgists. The author discusses at length details of the equipment of electrically-driven rolling mills. Either the direct-current or the three-phase-current system is applicable. By field regulation in the former case or by inserting resistances in the rotor circuit in the latter case, the speed can be changed. In order to make use of the fly-wheel effect of the large masses used in rolling mills, the motors should show some reduction of number of revolutions when load is thrown on. If the electric current is supplied from a lighting network, care should be taken to provide means so that the fluctuations of load do not react upon the lighting network. In such cases an intermediate converter plant either with a heavy fly-wheel or with a storage battery would be used. The author discusses at some length the economy of generating the electric power by using the blast furnace gases for driving gas engines coupled with dynamos. If the rolling mill is very near the blast furnaces it could, of course, be driven directly by gas engines; but if it is at some distance it is preferable to use the gas engines for generating electrical energy. He gives an estimate of cost of operation of a rolling mill with a yearly output of 300,000 tons under such conditions, and finds that the cost of operation per year would be about $20,000 with the electrical system, against $52,000 to $90,000 with a steam plant. Since the first cost of installation of the electrical plant is estimated as about $90,000, it is seen that this cost will be covered within a few years by the saving in the cost of operation.—*Stahl und Eisen*, February 15.

Indian Railway Workshops.—A note on the recently built workshops of the Bengal-Nagpur Railway at Kharagpur, India. Three 200-kw steam dynamos generate direct current at 220 volts and three-phase current at 140 volts. Direct current for power purposes is distributed by means of lead-sheathed cables, laid in stone troughs filled in with bitumen. The lighting wires are carried overhead on porcelain insulators supported on iron poles; 110 direct-current motors, ranging in power from 1 to 50 hp, are employed for driving the machine tools, cranes, etc. Many of the larger motors may be regulated in speed in the ratio of 2:1 by means of field rheostats. Small tools are driven in groups from short lengths of shafting. Three-phase currents at 2,200 volts are transmitted by two independent overhead lines to the pump house (three miles distant) where two pumps, each capable of delivering 30,000 gallons per hour, against a total head of 165 ft., are driven by two 45-hp, three-phase induction motors.—Lond. *Elec.*, February 19.

TRACTION.

Slot Point.—An illustrated description of the new slot point to be used on the lines of the London County Council tramways. In conduit tramways the divergence of the two slots at junctions has always been a source of trouble, due to the fact that the merging of the slots one into the other creates an objectionable width of opening, which, with ¾-in. slots, sometimes amounts to 2 in. The narrow rubber tires of light vehicles drop into this opening, causing a very unfavorable wrench when the wheel leaves the slot. The slot tongues which are used to divert the plough are made in the form

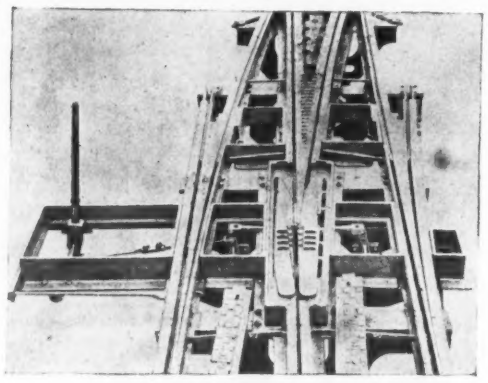


FIG. I.—SLOT POINT.

of flat steel plates sliding backwards and forwards in resistances in the side castings. These work at a distance of 1⅝ in. from the top surface of the slot rail. On these plates a number of projections are arranged so as to come within ⅜ in. of the road surface at the fixed slot point, thereby reducing the depth at the opening by 1¼ in. The nose of the fixed slot point is tapered off to the level of the projections, so that any wheel riding on the slot tongue is easily carried on to the point. The projections are divided by radial slots, in order to clear the strengthening ribs on the long cast-steel cover. In Fig. 1 the lids of the slot points and the covers of the road boxes have been removed to show the arrangement of the slot tongues.—Lond. *Elec.*, February 19.

Single-Phase Traction.—SCOTT.—A discussion of the general features of the Lamme single-phase series motor. Large as well as small motors may now be operated successfully on a period of 25 cycles, and under certain conditions the motors may be operated on ordinary direct-current railway circuits. A feature of this motor is, in fact, its conformity to the standard type of direct-current motor. If wound for 250 volts, two in series are suitable for operation on a 500-volt direct-current circuit, and a four-motor equipment may be operated with an ordinary type of series-parallel control. Such an equipment of single-phase motors with rheostatic control may be operated either upon a 500-volt direct-current circuit, or upon a 500-volt alternating-current circuit, or upon a high-voltage trolley circuit of say 1,000 to 3,000 volts, the voltage being reduced by a transformer on the car. This enables interurban cars to be operated on direct current in cities and on altenating current across the country.—*Elec. Club Jour.*, February.

Mountain Railroad.—THOMANN.—The first parts of a detailed description of the Mendel road in Southern Tirol (which is well known to every traveler going from Verona to Tirol). This is the longest and steepest of all cable roads so far built. The road is divided into two sections. The first, from Kaltern to St. Anton (difference in level between the two ends 105 meters) is an ordinary adhesion road with 6.2 per cent. maximum grade, 500-volt direct current being supplied from a trolley wire and the rails being used for the return current. The second section has a difference of 854 meters between the levels of the two ends and is operated as a cable road with 64 per cent. maximum grade. The arrangement is that ordinarily used, one car going up while the other car runs down.—*Elek. Bahnen.*, Nos. 3 and 4, February.

REFERENCES.

Conductor Rails.—STEVENS.—Illustrations of a section of the new track on the Liverpool overhead railway.—Lond. *Elec.*, February 19.

Hamburg.—An account of the discussions which have been going on for a long while in Hamburg concerning the question whether for the city and suburban roads, traction on rails or a suspended train (as in Barmen-Elberfeld) should be adopted. The final decision was in favor of a road on rails.—*Elek. Bahnen.*, No. 4, February.

British Tramways.—A description of the Bath tramways which were recently opened. The line is equivalent to 16 miles of single track. The power house contains three steam-driven, 200-kw compound generators. The trolley system is used.—Lond. *Elec.*, February 19.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Automatic Devices.—A long editorial in which it is claimed that in view of the importance of labor-saving devices in American industries due to the labor conditions in this country, the development of automatic devices has been far in excess of the requirements of other countries and even in some respects in excess of the requirements of the United States. It is thought that every branch of electrical engineering has been attacked by the craze for automatics to such a point that a word of warning is now in place. While the use of several motor cars instead of a single locomotive is preferable, the simplest means of controlling all motors from one controller would necessitate the employment of several cables conveying heavy currents along the whole length of the train. To avoid this the multiple-unit systems have been devised and while the systems already in use apparently work well, yet a step further in the long chain of independent automatic devices would as likely as not so weaken the whole connection as to cause electric raliway engineers to return in a panic to a more primitive system. While the "remote control" switchboard is recommended to some extent, it is thought that some modern switchboard designs, especially in telephony, are bewildering in their ingenuity and perplexity. While a certain amount of automatic devices are necessary in electric works, yet it is dangerous to follow the fashion too far. The writer quotes the old saying attributed to Edison that the best automatic device is a "nigger."—Lond. *Elec.*, February 19.

WIRES, WIRING AND CONDUITS.

Electric Perforation.—KROGH.—A communication referring to the law of Baur, who gives the relation between thickness of material and perforation voltage by the following formula: $V = c\, d^{\frac{3}{2}}$. The present author says that while this formula gives very good results for all practical purposes, it cannot be considered as an exact law, since by testing liquid insulation materials distinct although small discrepancies from this law can be traced.—*Elek. Zeit.*, February 18.

REFERENCE.

Capacity of Conductors and Cables.—LICHTENSTEIN.—The conclusion of his article. He summarizes in a table the mathematical formulas which he has derived for the capacity of two parallel overhead conductors, of a three-phase overhead line, of a two-wire cable, of a three-phase cable, and of a concentric single-phase cable. He applies the formulas to some numerical examples.—*Elek. Zeit.*, February 18.

ELECTRO-PHYSICS AND MAGNETISM.

Radioactivity.—RUTHERFORD AND BARNES.—In a Physical Society paper Rutherford discusses the question whether the radioactivity of radium depends upon its concentration, radium bromide being used either in pure solid form or dissolved in a solution of radium chloride. He found that the radioactivity is independent of the concentration. This shows that the rate of disintegration of radium and its products is not appreciably altered by the bombardment of its own powerful radiations, and renders it probable that the conductivity of radium is, in all cases, directly proportional to the amount of that element present. In another paper, by Rutherford and Barnes, the heat emission of radium is studied. This is shown to be an accompaniment of the expulsion of α particles and the time variation of the heating effect of each of the different active products is the same as the time variation of the activity measured by the α rays. The heat emission of radium is probably due in part to the kinetic energy of the expelled α particles and in part to the energy released consequent upon the rearrangement of the components of the systems left behind after the expulsion of the α particles. The following estimation of the energy given out by radioactive bodies is interesting: One gram of the emanation radiates during its life an amount of energy lying between 2,000,000,000 and 20,000,000,000 gram calories. One pound weight of the emanation would initially radiate energy at the rate of 10,000, to 100,000 hp and would emit during its life an amount of energy between 60,000 and 600,000 hp-days. There can thus be no doubt that matter, under special conditions, is capable of emitting an amount of energy enormous compared with that realized in the most intense chemical reactions. On the disintegration hypothesis this energy is derived from the energy latent in the radium atoms and is released during the successive stages of their disintegration.—*Phys. Rev.*, February.

REFERENCES.

N-Rays.—Various papers on recent developments on this subject. Lambert has found that soluble ferments emit N-rays, especially the ferments concerned in the digestion of albuminoid matter. Meyer has found that plants emit N-rays whether they are kept in the dark or exposed to light, and that there is no difference due to the action of light. Gutton has found that the effect produced by N-rays upon a luminescent screen may be imitated by means of a non-uniform magnetic field. Charpentier has discovered two new effects of N-rays. If a strong source of N-rays is placed 4 cm. behind the top of the skull and a little above it, not only are faintly luminous objects perceived with greater brightness and detail, but in absolute obscurity a faint luminous cloud is perceived. The other new effect is the enlargement of the pupil when the conducting plate is placed over the seventh cervical vertebra.—*Comptes Rendus*, January 25 and February 1; abstracted in Lond. *Elec.*, February 19.

Velocity of Light in a Magnetic Field.—MILLS.—An account of experiments in which, as in former investigations, the method was to note the shifting of the interference bands formed by the divided portions of the same beam, one portion of which has traversed a medium in a magnetic field. He used the apparatus of Morley and Miller. A distinct shifting of the fringes was noticed and these shiftings increased with the current.—*Phys. Rev.*, February.

ELECTRO-CHEMISTRY AND BATTERIES.

Conductivity of Solutions in Methyl Alcohol in the Neighborhood of the Critical Points.—KRAUSS.—The conclusion of his paper; he now discusses the results. Solutions in methyl and ethyl alcohol possess maxima of electric conductivity, the former in the neighborhood of 150° C. Solutions in ethyl and methyl conduct beyond the critical point, the former conducting much the better. The temperature coefficient of a solution in methyl alcohol undergoes a certain change at a critical point. The vapor of a solvent may become a very good conductor in the neighborhood of the critical point. The conductivity increases very largely for a saturated vapor as the critical point is approached, owing to increasing density of both solvent and solute.—*Phys. Rev.*, February.

Alloys of Copper and Cuprous Oxide.—HOFMAN, GREEN AND YERXA.—A fully-illustrated account of a "laboratory study of the stages in the refining of copper." The authors studied by metallographical methods the various alloys of copper and cuprous oxide and show that area measurements of enlarged micrographs of pure coppers containing less oxygen than the eutectic give good valuations of the oxygen contained. It also seems entirely feasible to make a close estimation of the percentage of cuprous oxide contained in a sample of copper by simply examining a polished surface with the microscope when once some experience has been gained.—*Electrochem. Ind.*, March.

REFERENCES.

Electrode Voltage.—JOHNSON.—An article in which the author gives the theory of the electrode voltage first on the basis of the principles of thermodynamics and afterwards on the basis of the osmotic theory of solutions.—*Electrochem. Ind.*, March.

Cadmium Cell.—BARNETT.—An account, illustrated by diagrams, of some experiments on the polarization and recovery of cadmium cells.—*Phys. Rev.*, February.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Electric Units.—BAUCH.—A communication referring to the recent proposal of Teichmüller, with whom he agrees in most points. He does not approve, however, his proposal to substitute the name weber for gilbert. He makes instead the following proposition: By the name gauss we indicate at present the numbers of lines of force per square centimeter as well as the m.m.f. per centimeter length. These are now two different things, and the distinction between them is not purely academical, but has practical importance. For instance, everybody who designs machines knows that we may have at the same time density of lines of force per square centimeter in air-gap = 8,000 c.g.s. units and m.m.f. per centimeter in air-gap = 6,000 c.g.s. units. If one writes this, using the name gauss in both cases one has air-gap = 8,000 gausses in one case, and in the other case air-gap = 6,000 gausses. Errors in the further calculations are then easily made. The present author suggests to call m.m.f. per centimeter, gauss, and the density of lines of force per square centimeter, weber, then one has to write in the above example air-gap = 8,000 weber and air-gap = 6,000 gausses. To use the two names, gauss and weber, for two similar units indicates that these two scientists worked jointly in many important investigations. Concerning the possible objection that the two quantities differ only by the factor μ (which is often considered as a pure number), he says that horse-power and watt also differ by a constant factor only. Nevertheless, we measure the output of a motor in horse-power and the power supplied to it in watt.—*Elek. Zeit.*, February 18.

Applications of the Oscillograph.—MORRIS AND CATTERSON-SMITH.—An account of some experiments in which the oscillograph was made use of for recording magnetization curves of transformers during working. The method is an application of the double oscillograph of the Duddell pattern and the device consists in passing through one of the oscillograph strips a current proportional to the magnetizing force, and through the other a current proportional to the induction density. A parallel beam of light from an electric arc is reflected from the mirror attached to the one strip, so that the reflected beam is subject to an angular vibration in a horizontal plane proportional to the magnetizing force. This reflected beam is received on one of the smaller faces of a right-angle prism placed so that its large surface is inclined at 45°. The vibrations of the beam are thus transformed into movements in a vertical plane. The light is then received on a silvered lens (acting as a concave mirror of about 18 in. radius) and focussed back on the second oscillograph mirror, so that the final reflected ray partakes of both vibrations as co-ordinates in the usual manner of B.-H. curves. The method of superposing the vibrations of two oscillograph strips in planes at angles is also applicable to the estimation of small power factors, since a straight line can only be obtained as the resultant vibration when the two waves in these strips are exactly in phase. They also made experiments on the currents in a direct-current shunt-wound motor and in a rotary converter under varying conditions of load.—Lond. *Elec.*, February 19.

REFERENCE.

Testing the Magnetic Properties of Sheet Iron.—An illustrated description of the method of Richter, used by the Siemens and Halske Co. for determining the iron losses in whole sheets, which has already been noticed in the Digest.—Lond. *Elec.*, February 19.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephony.—STOSBERG.—An article in which the author proposes to provide a resistance in shunt with the microphone. The resistance of a microphone when unused is about 20 ohms, and that of the primary windings of the induction coil about 1 ohm. If in this circuit two cells are used in series, each of 1.3 volts and 1.5 ohms internal resistance, the current will be 118 milliamperes, or 60 milliamperes if only one cell is used. The disadvantage is that the contact points of the carbon particles as well as the carbon surfaces of the membrane are burned. If the carbon of a microphone, which has been used for some time is investigated, it is found that it is surrounded by an ash-like powder of low conductivity. While it is impossible to increase the primary resistance, the above disadvantage may be overcome by connecting a resistance of say 60 ohms in shunt with the microphone. The joint resistance of the circuit then becomes about 16 ohms. With two cells the current becomes 161 milliamperes, of which 120 flow through the microphone resistance and 40 through the sunt resistance. With one cell of 1.3 volts, the current becomes 82 milliamperes, of which 61 pass through the microphone and 21 through the shunt resistance. He has found that the formation of sparks is thus entirely avoided and the carbon is not burned. The shunt resistance is best made of nickel wire with silk insulation, of a diameter of about 0.16 mm; 4 meters of this wire are sufficient to give the 60 ohms, and may be easily rolled up to form a ring of 5 cm. diameter. In exchanges it is preferable to use instead of the artificial resistance a galvanoscope of 60 ohms resistance. This allows the attendant to control at any time the condition of the microphone battery; it would be automatically connected to the circuit while a speech is transmitted.—*Elek. Zeit.*, February 4.

MISCELLANEOUS.

Tests of Lubricating Oils.—WILKENS.—An illustrated paper read before the Berlin Electrical Society in which he describes methods, used by the Allgem. Elek. Ges. of Berlin, for testing lubricating oils. The author points out that for all methods of operation it is of importance that a sufficiently thick film of lubricating oil is always between the two sliding surfaces; for this purpose the oil should have sufficient consistency. For some methods of operation this is much more important than a low internal friction coefficient of the oil. For instance, in modern electric central stations with large, directly-coupled machine sets of 1,000 or more hp, it is of small account whether the few bearings in it get heated to 40° or 45° C., since the increased friction loss, due to the increased temperature, is scarcely noticeable in the fuel consumption. On the other hand, in all cases where friction losses represent a large proportion of the total power consumption, for instance, in plants with much shafting, a small increase of the friction resistance at every sliding surface will have an important influence upon the total power consumption and on the economy of operation. For this class of plants an oil of a low internal friction coefficient should be chosen. The author emphasizes the importance of the tests of the physical properties of lubricating oils, the most important properties being the internal friction resistance and the consistency of the oil. The internal friction resistance is determined by the apparatus shown in Fig. 2. *K* is a closed chamber filled with the lubricating oil to be tested and provided with a wheel, *F*, the axle of which is driven by an electric motor. This chamber communicates with two columns, *R R'*, which are filled about to one-half with the oil. When the wheel revolves the oil inside the spokes of the wheel moves along an outside layer of oil, which is in direct connection with the oil in the two columns. On account of friction between the two oil surfaces this outside layer of oil is set

into motion and the level of the oil rises in the one column and falls in the other, until a stationary condition is reached which depends upon the speed of the wheel and the properties of the oil tested. From the difference of the levels in the two columns, the specific gravity and the speed of the wheel, the internal coefficient of the oil may be found. To test the internal friction of the oil for various temperature and speeds, the temperature of the oil is varied by means of an electric heating device and the speed of the motor is changed. A large number of curves are reproduced which were determined in this way for different oils. From the torque of the motor the consistency of the oil can be determined. If k is the torque for petroleum for a certain speed and K the torque of an oil to be tested for the same speed, then the consistency of the latter oil in per cents of the consistency of petroleum is $100\ (K - k) \div K$. The results obtained by this apparatus were found to give correct indications of the suitability of an oil for certain purposes.—*Elek. Zeit.*, February 18.

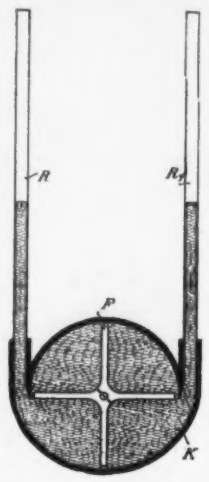


FIG. 2.—TESTING OIL.

REFERENCES.

American Engineering Schools.—WALMSLEY.—A paper read before the British Institute of Electrical Engineers on "Transatlantic Engineering Schools and Engineering." In comparing American with English colleges, he endeavors to show that candidates for entrance to American engineering colleges are older and better fitted to receive the training than those in England. He recommends the abolition of the premium system in English technical schools, their better equipping and staffing, more encouragement at home for graduates and wider knowledge that college training is absolutely essential. Some form of the sandwich system should be adopted.—Lond. *Elec.*, February 19.

Electric Club Journal.—This is a new monthly published by the Electric Club, of Pittsburg. The first number contains a good portrait of George Westinghouse, with an account of his life by Taylor. Other articles are abstracted elsewhere in the Digest.—*Elec. Club Jour.*, February.

Restoring Full Telephone Service in Baltimore.

Details were given recently in these pages of the great fire in Baltimore, and its damage to the various electrical services, including the telephone, which was, of course, in universal use in the burned district. The principal office of the Chesapeake & Potomac Telephone Company was destroyed and some 7,500 of its telephones were silenced by the fire. No one imagined that anything like a complete restoration would be accomplished within four weeks from the date of the fire. Not only was the St. Paul central office totally wrecked, but the building in which it was located was so badly damaged as to be entirely unfit for use.

On the Saturday night before the fire two new central offices had been opened. On the Sunday night following, while the fire was still raging, it was decided to enlarge one of the new offices which had been equipped to serve about 4,000 telephones, so as to serve over 12,000 lines. Parts of a new switchboard then in Washington ready for installation in that city were immediately shipped to Baltimore and the necessary cables were ordered from the Chicago factories of the Western Electric Company. Within two weeks the equipment for 4,000 telephones was in place and the telephones were rapidly connected. The entire installation was completed on February 29, 21 days after the fire originated.

To accomplish this men were taken to Baltimore from Philadelphia, Washington, New York, Boston and other cities. The men were organized to work in three shifts of eight hours each, and the work was pushed forward continuously day and night. A special commissary department to supply lunches and coffee was organized, and all important shipments of supplies from New York and Chicago which did not come by express were accompanied by men to prevent delays and the possibility of loss on the way.

The new switchboard is 135 ft. in length and contains 160,000 "jacks." In constructing the board 500,000 hand-soldered connections were made. Thirty-five miles of switchboard cable, containing 2,000 miles of wire, were used.

One week after the fire it was decided by the company's officers to reopen the South office, to serve subscribers in the southern part of the city below Pratt Street. The work of altering the building to accommodate a larger equipment than had previously been used there, and of installing equipment to serve about 4,000 telephones, was pushed forward vigorously, an emergency board being expressed from Chicago for this purpose. The installation was completed February 29 and put in service March 2.

The loss of the telephone company was not confined to the property actually destroyed, as its cables and lines in the burned district were rendered useless for the time being. The cable factories were set in motion, and as much as 8,000 miles of wire were made into cables, taken to Baltimore, drawn into the subways and spliced. This work was interfered with to a considerable extent by the wrecking gangs who were engaged in tearing down walls in the vicinity of the manholes.

In carrying out its plans made at the beginning of the year the company had just contracted for the erection of a three-story fireproof building 42 x 80 ft., designed for telephone use exclusively, to be located near Wolfe and East Fayette Streets. This office, when completed, will serve East Baltimore, and meanwhile subscribers in that part of the city will be connected to the Mount Vernon exchange. None of the work done in the restoration of the system is of a temporary character, the cables and equipment used being of the most modern type and the work of installation being done in the most skillful manner.

Storage Batteries Used for Thawing Water Pipes.

A novel departure in the process of thawing out frozen water pipes is reported by the Storage Battery Supply Company, of 239 East Twenty-seventh Street, New York City. We give below a description of its process as adopted recently in thawing out pipes in Borough Park, Brooklyn. President T. D. Bunce says:

"Our method consists in taking a load of storage batteries, arranged for high amperage work with variable connections, adjustable for high amperage and low voltage on large pipes and low amperage on small pipes. In the present case we supposed the service pipe, which was ½ in. in diameter, was all that was frozen, so we connected our feeders to the water main in the street and the outlet in the cellar of the party's house. The pipe was about 80 ft. long and with about 15 volts and 300 amp.; we had raised the temperature of the service pipe to about 150°, where it was exposed in the cellar.

"We continued this for about twenty minutes, but no water came, so we concluded that the main was frozen, the party being the last man on it, and as the adjacent house had a supply of water we dug another hole and connected our feeders at this point and also at the first location on the mains in the street. This main was 2-in. galvanized pipe and the distance was about 20 ft. We used a pressure of 6 volts, but do not know how many amperes were used, as our meter did not read high enough. I presume it must have been in the neighborhood of 1,000 or more. From the time we threw on our current it required three minutes to have running water in the house."

Underground Cables in Baltimore Fire.

The Baltimore fire has been the unfortunate means of settling many disputed points for the engineers of this country, and it has, among other points, emphasized most forcibly, in the minds of interested observers, the superiority of underground cables for electrical transmission of power, as compared with old overhead methods.

The Standard Underground Cable Company has installed during the past few years in Baltimore many miles of underground cable, in the municipal subway, for the Western Union, Baltimore & Ohio Telegraph Companies, the Maryland Telephone Company, the City Fire and Police Departments and the United Railways & Electric Company. The main conduit lines run the entire length of the burned district and the manhole covers were in many cases covered with piles of hot brick and stone to a depth of twenty feet.

In spite of the intense heat there is, so far as is known, not a single instance of trouble on the cables in manholes or subway except where exposed ends of cables were destroyed by the fire; and the cable system is in perfect condition to-day.

The three-conductor cables installed for the United Railways & Electric Company over a year ago, and which terminated in the new and unburned portion of the Partt Street power house, extended the entire length of the burned district; and were carrying current to the sub-station at 13,000 volts the second day after the fire, without any interruption to service.

Electric Power Distribution in a Sash and Door Mill.

The new mill of the Balitmore Sash & Door Company, Baltimore, Md., is a good example of modern methods, and illustrates the great advance made in machine installation and factory equipment during recent years. The arrangement of apparatus shows careful and

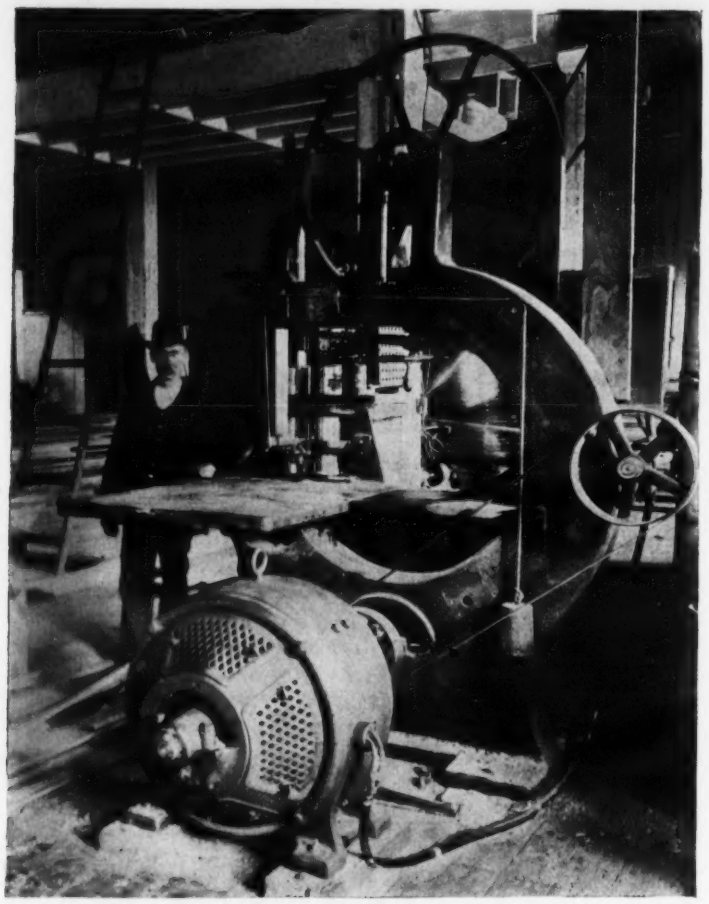


FIG. 1.—BAND SAW.

skillful planning and permits easy handling of material, with a maximum saving of time and labor. No space is wasted, and yet about each machine there is abundant room for operation, together with free head room and a noticeable absence of the intricate belting and shafting usually found in wood-working establishments. Good light abounds everywhere. These obvious advantages are largely due to the foresight of the managers of this company in adopting a system of electric distribution of power, and a well-thought-out plan of motor drive. The plan of driving larger machines each by its own motor, is skillfully combined with group driving for lighter apparatus, the conditions peculiar to the work to be done being the determining factor in this division.

The mill has a present capacity of 500 doors and 600 complete window sashes per day of ten hours, or approximately 150,000 doors and 180,000 sashes in an ordinary working year. A specialty is made of high-grade cypress and white pine.

The main building contains two floors, the first occupied by the door and moulding departments, while the second is largely devoted to the manufacture of sashes. An electrically-operated elevator connects the two and provides adequate facilities for handling the necessary material and machinery.

Exhaust pipes over each machine collect the sawdust and shavings and feed into a storage tank over the boiler house outside the main building. In this way cleanliness is always secured, and fuel, sufficient for the power needed, is delivered to the boilers, practically without handling and at an almost negligible cost. Draught for this purpose is provided by a Sturtevant blower, mounted on a platform under the ceiling of the first floor and driven by a 42-hp Westinghouse open type multipolar motor. The entire system of blower,

FIG. 2.—CUT-OFF SAW.

piping, storage tank, etc., was installed by the Dixey Blowpipe Company, of Baltimore.

The power plant is located in a separate building. Steam at 80 pounds pressure is developed in a pair of horizontal return tubular boilers, installed by the Thomas Brassher Co., of Baltimore, and equipped with the appliances necessary for burning sawdust fuel. All dust and dirt of fuel are confined within automatic feed pipes leading to the furnace. Boiler and engine room adjoin but are separated by a brick partition.

A 155-hp Ball & Wood simple automatic engine, direct-connected to a 100-kw, 250-volt, direct-current Westinghouse generator is at

FIG. 3.—DRILL STILE BORER.

present in service. A second unit will be added later, as the mill is to be enlarged. A marble switchboard, with all requisite apparatus, furnishes control for the power and lighting circuits, which are run to distributing panels on each floor of the main building. From these distributing centers branch lines run to the various motors and lamps in each department. Means are also provided for the control of each motor at the machine or group of machines which it drives.

Semi-enclosed Westinghouse direct-current "Type S" motors have been adopted as standard, though a few of the multipolar open type are also used. Strong and compact design, high efficiency, large overload capacity and cool operation combine to make this type of motor peculiarly suited to the requirements of machine driving. The

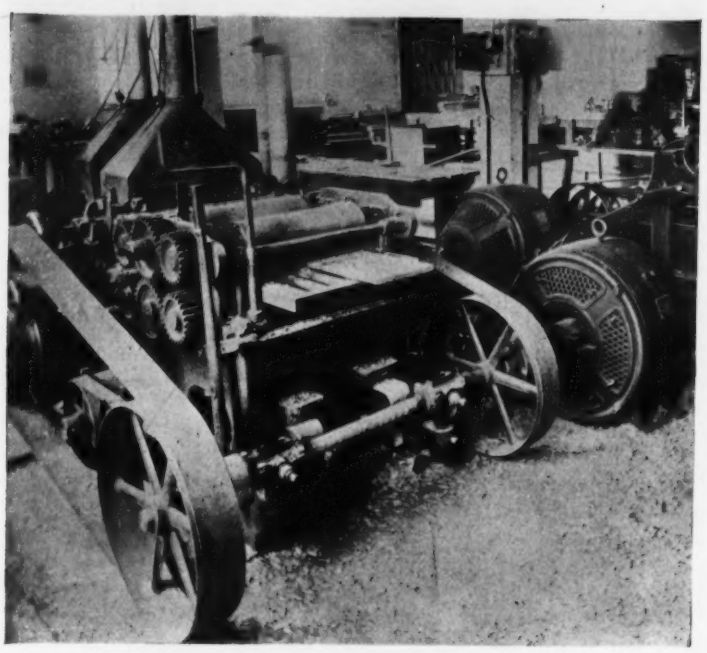


FIG. 4.—MOULDER AND PANEL RAISER.

larger motors are generally compound, the smaller shunt wound. There are, at present, about thirty motors with approximate total capacity of 250 hp. The machine equipment is, in part, as follows:

16-in. cut-off saw, 4,000 ft. per minute, made by J. A. Fay & Co., with 3½-hp, 700-r.p.m. motor. End paneler, made by E. B. Hays Machine Co., with 3½-hp, 700-r.p.m. motor. Panel raiser, capacity 600 panels per day, E. B. Hays Machine Co., with 15-hp, 600-r.p.m.

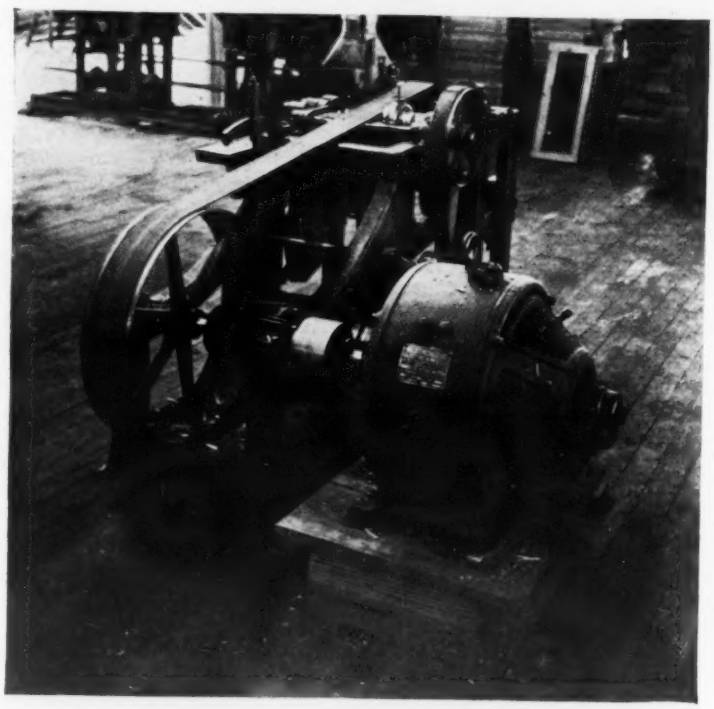


FIG. 5.—SASH STICKER.

motor. 14-in. moulder, J. A. Fay & Co., with 15-hp, 900-r.p.m. motor. 9-in. moulder, J. A. Fay & Co., with 10-hp, 1,000-r.p.m. motor. No. 4 "American" 40-in. band resaw, with 10-hp, 630-r.p.m. motor. "American" double surfacer, with 7-hp, 900-r.p.m. motor. 42-in. band saw, with 10-hp, 600-r.p.m. motor. 16-in. swing saw, with 3½-hp, 1,600-r.p.m. motor. Vertical shaft variety moulder, 3,000 r.p.m., J. A. Fay & Co., with 2-hp, 1,200-r.p.m. motor. 42-in. sander, J. A. Fay & Co., with 15-hp, 650-r.p.m. motor. Scroll saw, with 2-hp, 1,200-r.p.m. motor. Eight-drill rail borer, E. B. Hays Machine Company, capacity 600 rails per day, with 6-hp, 700-r.p.m. motor. Door clamp, E. B. Hays Machine Co., one door per minute, with 3½-hp, 1,120-r.p.m. motor. Dowel driver, E. B. Hays Machine Co., with 3½-hp, 700-r.p.m. motor. Double-end tenoning machine, E. B. Hays Machine Company, with 16-hp, 1,100-r.p.m. motor. 28-in. drill stile borer, E. B. Hays Machine Co., with 10-hp, 630-r.p.m. motor. This machine will in one day turn out material for 1,200 doors.

On the first floor a 3½-hp motor operates a small group of emery wheels and saw files in the repair shop. In the sash department

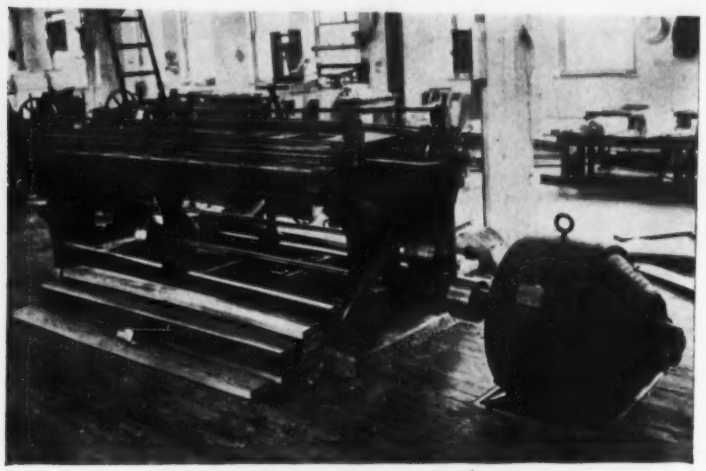


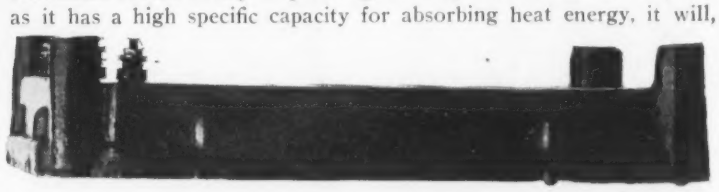
FIG. 6.—SPINDLE RAIL BORER.

10-hp and 15-hp motors, respectively, operate two short line shafts, to one of which are belted two "American" sash stickers, one hollow chisel, one franking machine, one buzz planer and one gang rip saw, while the other drives a six-in., four-sided moulder, one combination saw, one single-end tenoning machine, one "American" sash dovetailer, one chain mortiser, one pony planer, and one emery grinder.

During six months operation the mill has more than met with the expectations of its owners, and has again demonstrated the convenience and economy of motor drive for work of this character. Large orders have already covered the entire output and made an increase in capacity necessary. Additions are being prepared and largely increased facilities provided to meet the growing demand for a well-made product.

Rheostats for Trolley Brakes and Elevators.

The Ward Leonard Electric Company, of Bronxville, N. Y., has devoted some time to the subject of rheostats for use with electrically-operated brakes for trolleys, elevators, etc. Its resistance box for this purpose is constructed with a resistance ribbon in a thoroughly enameled iron box filled with sand, the terminals being brought out. The resistance ribbon or strip is of a special alloy having a practically zero coefficient and is practically of a capacity sufficient to carry overload. Enamel being the best insulator known, protects the rheostat against any possibility of grounding. The sand holds the resistance ribbon firmly in place against any mechanical defects, and as it has a high specific capacity for absorbing heat energy, it will,



RESISTANCE RIBBON.

in the case of excessive overload, absorb the heat energy generated and transmit it to the iron casting, where it will be radiated at a low temperature.

As the box is entirely enclosed in enamel and filled with sand, it is positively protected against the action of the atmosphere, conditions of moisture, etc. These resistance boxes will stand great mechanical stresses, giving out only upon breakage of the casting, but can be readily opened for inspection by removing the cover.

Automatic Motor Starters.

J. L. Schureman & Co., of Chicago, have just incorporated some improvements in their automatic elevator motor starters. One of these is in the dashpot of the single-speed elevator controller, shown in Fig. 1. On this controller, as all who are familiar with the device know, the motor circuit is closed to give forward or reverse motion by a double-throw switch on the top of the rheostat. This switch is operated from the elevator. As soon as the motor circuit is closed, the solenoid mounted on the front of the rheostat, Fig. 1,

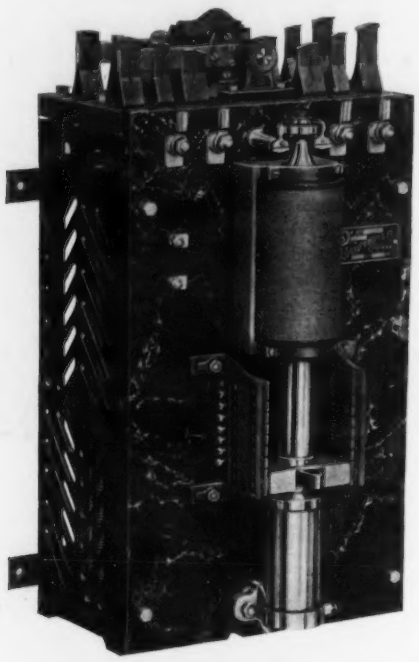
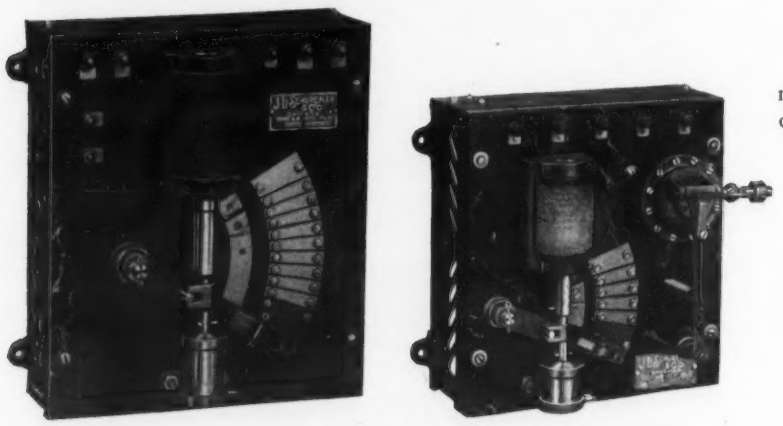


FIG. 1.—RHEOSTAT.

raises the piston slowly, carrying the contacts which gradually short circuit the rheostat. The speed of movement of the piston is determined by the resistance offered by the dashpot. Heretofore an oil dashpot has been used, but in order to get away from any difficulties incidental to the handling of the oil, or the substitution of something else in place of oil by those unacquainted with the device, the company has adopted a vacuum dashpot. The piston working on this dashpot is packed with soft leather, which is held in place by a compressed spiral spring, which forces the leather gently against the walls of the dashpot. The piston in rising creates a vacuum in the lower end of the cylinder. The rate of operation is regulated by a valve in the bottom of the cylinder, which allows the air to flow into



FIGS. 2 AND 3.—AUTOMATIC STARTERS.

the vacuum chamber. On this dashpot a solid iron solenoid core can be used instead of the hollow solenoid core used with the oil dashpot. This permits the plunger to be operated with a smaller amount of energy than on the older type, and the solenoid core does not have to be worked at as high a current density as with the oil dashpot. When the plunger has reached the top of its travel so that the rheostat is short circuited, it can be held in place with much less current flowing in the solenoid core than is required to raise the plunger. Accordingly, a contact is provided just above the solenoid, so that when the plunger reaches the top of its stroke, the contact opens and a high resistance is inserted in series with the solenoid core. This high resistance is short circuited by the contact until the plunger reaches the top of its stroke. Formerly a carbon contact was used for this purpose. This contact has been replaced by small brass contact pieces which are easily renewed and can also be reversed, so as to be worn out on both sides; and the magnetic field created by the solenoid is used to break the arc at this point.

In Fig. 2 is shown an automatic starter for various kinds of stationary motors. This starter can be put to a great number of uses. Where a motor is to be started from a distance with an automatic starter of this kind, it can be done in either of two ways. The circuit to the motor can be closed; in which case the automatic starter will move the rheostat arm around at a proper speed until the motor is up to speed, or if it is desirable not to handle the main circuit, the circuit to the solenoid can be opened or closed to stop and start the motor. Even where it may not be necessary to stop and start a motor from a distance, it may be desirable on account of unskilled labor employed to take the rate of turning on current out of the attendant's hands. This can easily be done with an automatic starter of this kind. One common application of this starter is in connection with electric pumping outfits for maintaining an approximately constant level of water in the tank. In such a case, the gravity float switch, shown in Fig. 4, is operated by the float to open and close the motor circuit. The automatic starter, shown in Fig. 2, does the rest.

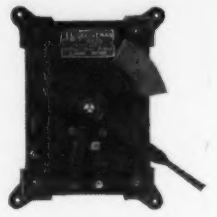


FIG. 4.—GRAVITY FLOAT SWITCH.

Fig. 3 is an automatic starter to be used in connection with an air compressor or any other device where the operation of the motor is to be made automatically dependent upon air, water, or steam pressure. The diaphragm valve, shown at the right, Fig. 4, can be set so as to close the circuit through the solenoid of the controller at any predetermined pressure. The motor will then start and continue to operate until the predetermined maximum pressure has been reached, when the diaphragm valve will cause the solenoid to be short circuited, which will allow the rheostat arm to fall back and stop the motor. On this controller the solenoid circuit is closed by the rheostat arm as soon as the motor starts, so that the contact made by the action of the diaphragm valve can be broken at any time after the motor starts. The motor can only be stopped by short circuiting the solenoid. It will be noted that in this pressure regulator, the circuit is never broken by the contacts of the pressure valve, as these contacts only act to close the circuits.

"All-Weather" Socket

The Benjamin Electric Manufacturing Company, of Chicago, is now making a weather-proof socket having a one-piece porcelain receptacle and a one-piece shell of aluminum or brass adapted for

ALL-WEATHER SOCKET.

½-in. or ⅜-in. iron pipe. It is large enough so that wires can be "looped" into it. The binding screws are accessible from the front. It is intended for use in places where exposed to rain or moisture. Two views of one of these sockets are shown herewith, which will give a good idea of the method of construction and the success attained in excluding moisture of any kind.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Inactivity characterized the stock market dealings although prices were firm at slight improvements, due to a better feeling as to the foreign situation. Another circumstance which influences the market was the continued and increasing ease of money, the accumulation of funds being held to indicate a slackening in trade and a decrease of demands. Decreases in railroad earnings as a result of the abnormally severe winter weather and the generally lighter traffic of many roads is still noted. A little activity was shown in Amalgamated Copper and Brooklyn Rapid Transit. The United States Steel stocks and 5 per cent. bonds were well supported. The electric stocks closed with net gains in all cases, while the net changes in the traction list were all on the negative side. There was uncommon activity in Commercial Cable, the sales of this stock aggregating 1,100 shares, at the uniform price of 191, which was also the closing quotation, representing a net gain of 4 points. General Electric followed next in point of net gain, being in this case, 3 points. Eleven hundred shares were dealt in at prices ranging between 159½ and 162, the closing price being 161. The faith in this stock is gratifying to say the least, in the face of the active preparations for entry into the electrical manufacturing field of another large and well-established concern. Westinghouse closed at the highest figure of the week—161—being a net gain of 2 points. Western Union made a net gain of ½ point, closing at 88. In the traction list, Brooklyn Rapid Transit closed at 39⅞, a net loss of ½ point, and Metropolitan Street Railway, 114, a like loss. The curb market for outside securities showed greater activity for a few issues, although most stocks were dull. Buying of Electric Boat shares was stimulated by the belief in some quarters that the government would order more submarine boats. The common stock closed at 24, and preferred at 55, these being net gains of 4 and 5 points, respectively. Otis Elevator also showed some activity. Following are the closing quotations on the stock exchange, March 8:

NEW YORK.

	Mar. 1	Mar. 8		Mar. 1	Mar. 8
American Tel. & Cable	84	85	General Electric	159	160
American Tel. & Tel.	121	121	Hudson River Tel.	..	..
American Dist. Tel.	22	22	Metropolitan St. Ry.	114¾	113¾
Brooklyn Rapid Transit	40¼	40¼	N. E. Elec. Veh. Trns.	..	..
Commercial Cable	188	185	N. Y. & N. J. Tel.	..	..
Electric Boat	20	23	Marconi Tel.	..	..
Electric Boat pfd.	49	53	Western Union Tel.	87⅜	88
Electric Lead Reduction	¾	⅝	Westinghouse com.	156¾	157
Electric Vehicle	7⅛	7⅛	Westinghouse pfd.	175	180
Electric Vehicle pfd.	10	10			

BOSTON.

	Mar. 1	Mar. 8		Mar. 1	Mar. 8
American Tel. & Tel	120¾	121	Western Tel. & Tel. pfd.	78	79
Cumberland Telephone	114½	114¾	Mexican Telephone	1⅛	1¼
Edison Elec. Illum.	230	*235	New England Telephone	118	118
General Electric	157	161	Mass. Elec. Ry.	18	18
Western Tel. & Tel	8⅛	8¼	Mass. Elec. Ry. pfd.	73¾	73

PHILADELPHIA.

	Mar. 1	Mar. 8		Mar. 1	Mar. 8
American Railways	43	43	Phila. Traction	..	97¼
Elec. Storage Battery	52	52	Phila. Electric	5¾	6¾
Elec. Storage Battery pfd.	52	52	Phila. Rapid Trans.	14⅜	14
Elec. Co. of America	7¾	7¾			

CHICAGO.

	Mar. 1	Mar. 8		Mar. 1	Mar. 8
Central Union Tel.	..	..	National Carbon pfd.	98	98
Chicago Edison	..	..	Metropolitan Elev. com.	..	15¼
Chicago City Ry	160	156	Union Traction	4¼	4½
Chicago Tel. Co.	..	..	Union Traction pfd.	30	30½
National Carbon	259¾	258¾			

*Asked

TELEGRAPH-TELEPHONE CONSOLIDATION.—According to the *Wall Street Journal,* an authority who has studied the telegraph and telephone situation says: "I see within a surprisingly short period of time a consolidation of the Commercial Cable Postal Telegraph Company and the American Telegraph and Telephone Company, and this is the basis of my calculation: Commercial Cable has just increased its capitalization by practically stock dividends of 300 per cent. T. Jefferson Coolidge, Jr., a director in the Bell, is named as one of the trustees of the new company to take over the Commercial Cable and the Postal. New York parties have recently bought Bell stock in this market. It is through this channel that the Bell people may get a wide market for their securities and a consolidation would lessen construction requirements fully $10,000,000 per annum. It is possible that the new Commercial Cable Company, organized under Massachusetts laws, will be the means of bringing the Bell Company back to Boston. The situation will bear careful watching. In event of a consolidation of the Bell and the Postal, I look for a consolidation of the Western Union and all the independent telephone companies in the United States. Such consolidations all around will save money for every concern interested."

SAN FRANCISCO LIGHTING.—The San Francisco Gas and Electric Company has placed on file its statement of its earnings and disbursements for the year 1903. The revenues amounted to $2,505,212.25, made up of gas sales, $1,445,304.60; electric current sales, $997,407.01; other sources, $62,500.64. The cost of gas was $1,146,873.82, and of electric current $783,381.83, a total of $1,930,255.65, leaving a net revenue of $574,956.60, from which dividends to the amount of $396,210.83 were paid, leaving at the end of the year a surplus of $178,745.77. It is represented that the original cost of the plant was $9,887,847.33 for gas, and $3,154,731.22 for the electric, a total of $13,042,578.55, and that the present cost of the plant amounts to $25,704,944.84, made up as follows: Gas—Plant, $9,476,879.05; pipes, $7,075,868.95; meters, $813,651.76; lamps, $77,489.67. Electric—Plant, $6,131,058.56; conduits, $1,933,320.46; meters, $196,676.39. It is declared that the present value of the plant cannot be determined. The capital stock outstanding is $15,794,284.36; bonds outstanding, $9,813,000; floating debt, $1,091,492.65.

DIVIDENDS.—The Electric Boat Company has declared a quarterly dividend of 2 per cent. on the preferred stock payable April 1. The directors of the Laclede Gas Company have declared the regular semi-annual dividend of 2 per cent. on the common stock, payable March 15. The International Steam Pump Company will close the common books March 21 for the payment of the fourth instalment of 1 per cent. of the 4 per cent. dividend declared on the common stock last June, which is payable April 1. Twin City Rapid Transit directors have declared the regular 1¾ per cent. quarterly dividend on the preferred, payable April 1. Chicago Telephone directors have declared the regular quarterly dividend of 2½ per cent., payable March 31. The directors of the Tri-State Telephone Company (the long-distance lines of the Twin City Telephone Company) have declared the third quarterly dividend, at the rate of 6 per cent. per annum, payable March 1, 1904. Manhattan Elevated has declared the quarterly dividend of 1½ per cent. and 1 per cent. extra, making 7 per cent. for the year. The executive committee of Western Union has recommended the regular quarterly dividend of 1¼ per cent. A dividend of $2 per share has been declared on Philadelphia Traction stock, payable April 1.

COMMERCIAL CABLE REPORT.—At a special meeting of the stockholders of the Commercial Cable Company, held on March 7 the proposed changes in the articles of association and bylaws of the company—providing for eighteen directors instead of fifteen, and that only stockholders can act as directors—were adopted. At the annual meeting, held after the special meeting, the retiring Board of Directors were re-elected. The statement of earnings for the year ended December 31, 1903, showed gross receipts of $11,025,634 and net earnings of $2,508,526. This with the surplus carried over from the previous year amounted to $2,056,055, out of which there were paid interest on bonds amounting to $800,000 and dividends on stock $1,200,000. Of the balance, $350,000 was placed in the reserve fund and $150,000 was added to the fund for the insurance of stations, apparatus, and repair steamer. The balance of income carried down amounts to $156,055. The total reserve fund at the end of the year was $5,372,520, and the insurance fund $1,020,862.

LARGE INDEPENDENT TELEPHONE DEAL.—Advices from San Antonio, Texas, of March 5 say: "E. H. Huntington has closed a deal through Frank C. Smith whereby he becomes owner of thirteen additional independent telephone exchanges in Texas. The new exchanges purchased are the Austin, Taylor, Temple, Belton, Sour Lake, Saratoga, Kountz, Woodville, Village, Kirbyville, Coll, Jasper and Bronson and the long-distance lines of the Commercial and Lone Star Companies. The price paid for these, together with the Houston, Galveston, Corsicana, Nacogdoches, San Marcos, Port Arthur and Liberty exchanges, previously acquired, exceeds $1,000,000.

UNITED STATES TELEPHONE BONDS.—Officials of the Federal Telephone Company are endeavoring to pool the entire issue of United States Telephone Company's bonds at 85 and interest for one year. A committee composed of Calvery Morris, H. R. Newcomb and F. S. Dickson will have power to sell these bonds. The Federal Company owns about $400,000 of these bonds, the Everett-Moore Syndicate $800,000,, outsiders $665,000, while $105,000 remains in the treasury.

Commercial Intelligence.

THE WEEK IN TRADE.—Reports indicate that trade and industry are still irregular, being active in favored sections, but hampered in others by the prolongation of winter weather, with incidental delays in transportation, car shortages and floods. Southern trade advices announce sustained activity; southwestern reports show improvement, and in the West the feeling is optimistic. In the East wholesale and retail trade are backward. There was more activity in iron and steel, and prices of some grades of iron are firmer, but the iron ore situation is yet unsettled. The agricultural situation is, on the whole, one of great strength, and there will be a record-breaking acreage in cotton. The general feeling prevails that settled weather will stimulate and revive general business, and be particularly helpful to building and other lines of out-of-door work, if undisturbed by foolish strikes. Collections are fair to good, and money is exceptionally easy for this season of the year. The features in iron and steel have been the purchase of nearly 100,000 tons by the leading interest, and reports of other sales aggregating as much more. In finished products, reports are more favorable, with mills running to their full capacity. The copper market is dull and uninteresting, and prices are unchanged. Quotations are: Lake 12½ @ 13¾ c.; electrotytic and casting stock 12⅜ @ 12⅝ c. The total exports of copper for February were 16,842 gross tons. *Bradstreet's* reports the number of business failures during the week ending March 3 as 195, as against 200 the previous week, and 171 the corresponding week last year.

LARGE EXPORT TRADE.—Exports of manufactures in January and in the seven months ending with January show a larger total than ever before in the same portions of the year. They amounted to $38,213,352, while the highest January record on any former occasion was that of 1900, when they were $35,586,940. For the seven months ending with January they amount to $250,214,936, and the highest record for that seven months' period in any preceding year was that ending with January, 1901, when the total was $239,564,064. Thus the total for January is two and a half million dollars in excess of any preceding January, and for the seven months ending with January is about eleven millions more than in any preceding seven months ending with January. These figures are shown by an analysis of the January exports just prepared by the Department of Commerce and Labor through its Bureau of Statistics. By far the largest increase occurs in manufactured copper, of which the exports in the seven months ending with January, 1904, are reported at $31,552,677, against $22,514,843 for the corresponding months last year, and $19,038,328 for the corresponding period of the year preceding. Iron and steel stand next in the list of manufactured articles showing an increase in exports. The total value of iron and steel exported in the seven months ending with January, 1904, is $59,125,780, against $55,997,942 in the corresponding months ending with January, 1903, and $57,310,128 in the corresponding months of the preceding year. For January alone the exports of iron and steel are $8,171,738, against $7,437,298 in January, 1903, making the increase for the single month $734,440, and for the seven months about three millions.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, has recently closed the following contracts for batteries of "Chloride" accumulator for lighting and power. The Union Electric Light and Power Company, St. Louis, Mo., for a battery having a capacity of 462 kw hours in its exciter sub-station. The St. Louis Transit Company will have installed 55 cells of Chloride in its new sub-station for the purpose of operating time switches. The World's Fair Automobile Transit Company have given an order for 100 sets of "Exide" batteries, each set consisting of 44 cells, to be used for the operation of the bus line, which will be in service at the Fair. Isolated lighting and power plants have been contracted for by the Union Trust Building Company, Detroit, Mich.; Morton F. Plant, Groton, Conn.; Bank of Renovo, Renovo, Pa., the the Tucker Electrical Construction Company, for the residence of A. G. Huntington at Bay Chester, N. Y. The Consolidated Railway Electric Light and Equipment Company has contracted for 1020-240 amp.-hour batteries for car lighting. The Herreshoff Manufacturing Company will install on Mr. Herreshoff's private yacht a complete lighting and power battery for operating the search lights, ventilating fans, and electric light throughout the boat. A smaller battery will also be used in connection with an electric launch to be used as a tender for this yacht. The yacht "Marjorie" and the yacht "Roxana" will each have a battery of "Chloride" accumulators installed for lighting purposes.

SOME C & C ORDERS.—The C & C Electric Company, 143 Liberty Street, reports receipt of a number of orders for generators, motors, series parallel equipments, etc. The Aluminum Press Company has ordered a 50-hp, also a 30-hp motor for driving machinery in its Dunellen, N. J., plant. The Greenwood Pottery Company, of Trenton, N. J., has requisitioned additional equipment in the shape of a 20-kw belted generator and a 15-hp motor, also a switchboard, for both light and power purposes. The Boston Navy Yard is to be shipped a 15-hp special motor and special controller for machine tool driving. The Garwood (N. J.) Foundry & Machine Company has ordered a 35-kw belted generator and switchboard for light and crane service. Six motors, varying from 2 hp to 6 hp and of special slow speed type, are to be installed for operating blowers in the University of Pennsylvania Engineering Building, Philadelphia. The Binghamton (N. Y.) *Press* plant is to have a 40-hp series parallel equipment for driving a Hoe printing press. A 20-hp motor, with special control, has been ordered by the Baltimore *Sun*, also to operate a Hoe press. A 75-kw direct-connected generator has been called for by the Miller Lock Company of Frankford, Pa., whose initial generating equipment is of C & C build.

MARCONI WIRELESS.—Communication has been established by the Marconi Wireless Telegraph Company between Broomfield, Essex, England, and Amsterdam, Holland, a distance of 200 miles over sea and 60 miles over land, for commercial wireless service. Arrangements have been made with a Dutch newspaper, the *Handelsblad*, to publish news transmitted daily from England. An agent of the Marconi system has a room in the Stock Exchange at Amsterdam, with private telephone connection with the wireless station, for the purpose of transmitting the daily Stock Exchange quotations to London. The La Gascogne and La Champagne, of the French line, and Grosser Kurfurst, Kaserin Maria Theresa, of the North German Lloyd line, have been equipped with the Marconi system, making the fleet between New York and Europe thus equipped, 38 vessels.

GENEVA ELECTRIC EQUIPMENT AND CONSTRUCTION COMPANY.—A petition in bankruptcy has been filed against the Geneva Electric Equipment and Construction Company, of 469 Fourth Avenue, New York City, by the following creditors: Alfred Gautier, $500; James Steinhauser, $500, and Samuel W. Levine, $150. It is alleged that the company is insolvent, and on February 27 admitted in writing its inability to pay its debts. The business was started in 1894, and the company succeeded to it in May, 1900, when it was incorporated with a capital stock of $10,000. It has never done a large business.

ELECTRIC BOAT ACTIVITY.—The Electric Boat Company is said to have orders for submarine boats the net profits on which will represent several hundred thousand dollars. Already the British Admiralty has bought nineteen boats from the company, and this number, it is stated, is to be increased to twenty-nine boats. A number of the Continental powers have purchased one or more submarine vessels from the company and the United States Government has several in commission.

IMPORTANT MEXICAN ELECTRIC RAILWAY PROJECTED.—It has been decided to construct an electric railway between Morelia, capital of the State of Michoacan, and Guadalajara, the principal city of the State of Palisco, Mexico. The distance between these two places is about 120 miles. Archbishop Silva, of Morelia, is primarily interested in the project. Carlos F. de Sandero, a Morelia engineer, has been commissioned to obtain the usual government concessions.

BALL ENGINE COMPANY, of Erie, Pa., is moving into new works on the western city limits and has its old plant for sale, equipped with power, tools, cranes, shafting, hot air heating system, electric light outfit, etc. It began building engines twenty-one years ago, and has sent them all over the world, particularly for electric light and power purposes. The new plant is unexcelled for capacity and facilities of production.

ELECTRIC TRACTION FOR PACHUCA, MEXICO.—An electric traction system is to be installed in Pachuca, a mining city of some 50,000 inhabitants, located in the State of Hidalgo, Mexico. The Hidalgo Railroad, which connects Mexico City with Pachuca, is completing the purchase of the mule tramways about 12 miles long, and they are to be converted into electric motive power.

STROWGER AUTOMATIC.—Stockholders of the Strowger Automatic Telephone Company at the annual meeting elected J. L. Kesner president, to succeed Elmer Washburne, put in charge by the court after a fight over the annual meeting last year. A. D. Nast succeeded Washburne as director. A. G. Wheeler, Jr., was elected vice-president, J. Siegel treasurer, and M. Sello, secretary.

LIGHTING PLANT FOR MAZATLAN.—The prosperous Mexican seaport town of Mazatlan, located in the State of Sinaloa, is to have an up-to-date Yankee electric lighting plant. Contracts are to be awarded early next month.

CEREAL PLANT TO BE ELECTRICALLY OPERATED.—The Patent Cereals Company of Geneva, N. Y., will shortly install a plant for the purpose of operating its factory electrically. The initial capacity will be about 300 hp.

General News.

THE TELEPHONE.

ABINGTON, ILL.—The Oak Grove Telephone Company has been incorporated with a capital stock of $500. The directors are: T. H. Castle, H. R. Griffith and others.

ANCHOR, ILL.—The Anchor Telephone Company has been incorporated, with a capital stock of $1400, to operate a telephone system. The directors are J. F. Ward and others.

HAZELTON, IND.—The Princeton & Vincennes Independent Telephone Company has been organized here, with C. S. Stevens as president.

INDIANAPOLIS, IND.—The Salmonia Telephone Company has been incorporated with a capital stock of $5000. The directors are: J. J. Kidder, Adam Lee and others.

INDIANAPOLIS, IND.—The Morning Star Telephone Company has been incorporated with a capital stock of $5000. The directors are: Jos. Allen, W. H. Williams and others.

EXIRA, IA.—On March 28 a vote will be taken upon the application of the Marne & Elkhorn Telephone Company, of Rorbeck, Ia., for a local exchange.

PILOT MOUND, IA.—The Pilot Mound Farmers' Mutual Telephone Company, with a capital stock of $10,000, has been incorporated by William Larson, O. W. Hinnan, George O. Durrell, George Owen and L. A. Carlson.

OWENSBORO, KY.—The Stromberg-Carlson Manufacturing Company is installing a 500-line switchboard for the Home Telephone Company. The exchange will connect with an extensive long distance system in this district.

BARBERSVILLE, KY.—The Hayden Telephone Company will build a line between Barbersville and Hayden. An exchange will be established at Manchester, and several toll lines built. John Woodward is general manager of the company.

FALL RIVER, MASS.—The Automatic Telephone Equipment Company has been organized here to operate an automatic telephone exchange and toll line.

BESSEMER, MICH.—The Wisconsin Independent Telephone Company is to extend its lines from Ashland to the Gogebic towns.

EATON RAPIDS, MICH.—The Eaton County Telephone Company is planning to build a line from Charlotte to this city.

CLARISSA, MINN.—A mutual telephone exchange is being promoted here.

EDGERTON, MINN.—The Edgerton Telephone Company has been granted a franchise.

WINONA, MINN.—The Winona Telephone Company will build a 20-mile exchange to Wiscoy.

NEW ULM, MINN.—The Minnesota Central Telephone Company will spend $12,000 on the exchange here.

PELICAN RAPIDS, MINN.—A local telephone company has been organized with a capital stock of $25,000. It proposes to start work in the near future.

STEWART, MINN.—The Electric 'Phone Company has been incorporated with a capital stock of $25,000. Mr. H. E. Posley is one of the incorporators.

LAKE CRYSTAL, MINN.—The Farmers' Telephone Company is the name of a new company just organized here with $25,000 capital. E. Upson is president.

HILLSBORO, MO.—The Festus Telephone Company has been incorporated by F. W. Brickey, W. F. Holt and others.

HARRISONVILLE, MO.—The Cass County Telephone Company, of Harrisonville, has been incorporated, to construct a telephone line, with a capital stock of $50,000. The incorporators are: W. B. Scruggs, R. W. Adams, Duston Adams, W. H. Scruggs and H. B. Moody.

ALBUQUERQUE, N. M.—The Pecos Valley Telephone Company has been incorporated with a capital stock of $50,000. The directors are: J. W. Poe, R. Chaves and others.

DUNDEE, N. Y.—The Dundee, Rock Stream & Reading Center Telephone Company has been organized here.

SYRACUSE, N. Y.—The Syracuse Telephone Company will probably issue bonds for $400,000 for the extension and improvement of its service in this city.

NORTH BOSTON, N. Y.—The Boston Valley Telephone Company has been organized to build a line between Boston and Hamburg. The officers of the company are: President, Fred Frank; vice-president, Philip D. Weber; secretary, Frank X. Weber; treasurer, Edward Heinrich.

BERGHOLTZ, OHIO.—The Bergholtz Telephone Company has increased its capital from $5000 to $20,000.

MANSFIELD, OHIO.—The Central Union Telephone Company will expend $30,000 in improvements on its plant here.

HICKSVILLE, OHIO.—The Hicksville Telephone Company has increased its capital from $25,000 to $40,000, and will make improvements.

WALDO, OHIO.—The Waldo Home Telephone Company has been organized with $25,000 capital stock, and will build a local exchange.

AKRON, OHIO.—The Springfield Township Rural Telephone Company, capital $10,000, has been organized by farmers of Springfield township.

CALDWELL, OHIO.—The Farmers' Independent Telephone Company has been organized here by Judge L. W. Wheeler, H. W. Kuntz and E. W. Spannagel.

KINGSVILLE, OHIO.—The Central Union Telephone Company has installed an exchange at Kingsville and is building a farmers' line throughout a wide district.

MARIETTA, OHIO.—The Marietta Telephone Company has been organized, with A. L. Gracey, president; F. P. Moats, treasurer, and A. C. Davis, secretary and general manager.

MIDDLETOWN, OHIO.—The Middletown Home Telephone Company, capital stock $10,000, has been incorporated by C. H. Osler, F. N. Ramsey, Albert Emanuel, R. E. Kline and H. P. Miller.

AUSTINBURG, OHIO.—The Austinburg Telephone Company has secured right of way from Austinburg to Geneva, and is asking for a franchise in Geneva. G. W. Mooney is at the head of the company.

PERRYSBURG, OHIO.—The Maumee Valley Telephone Company has been organized by Norman L. Harrison and others, with a capital stock of $15,000. Telephone lines will be built through Wood, Henry and Lucas counties.

TIFFIN, OHIO.—The Tiffin Home Telephone Company has increased its capital stock from $60,000 to $125,000. F. B. Myers has been elected president, and J. J. Kintz, secretary and manager. The company is planning improvements.

CHAGRIN FALLS, OHIO.—Fire in the exchange of the Chagrin Falls Telephone Company, a few days ago, damaged the office and practically destroyed the switchboard. The system supplies connection for farmers throughout a wide district.

HAMILTON, OHIO.—The Hamilton Home Telephone Company, the Oxford & Indiana Telephone Company, the Morning Sun Telephone Company and the Darretown Telephone Company have completed arrangements for the free interchange of calls. Towns within a radius of 40 miles will be connected.

STEUBENVILLE, OHIO.—Farmers of this vicinity have organized the Fernwood Telephone Company. John Gault has been elected president, and Joseph Scott, general manager. They have made an arrangement with the Reed's Mills Telephone Company to connect with all the towns in this vicinity. They are in the market for a small switchboard, as well as other material.

CARPENTER, OKLA.—The Elk City Northern Telephone Company has been incorporated with a capital stock of $5000. The directors are: Jos. Moad, D. L. Cliff and others.

MORGANSTOWN, PA.—At the annual meeting of the Conestoga Telephone & Telegraph Company recently held here, the board of directors was organized by the election of the following named officers: President, M. H. Hertzler; vice-president and secretary, Jacob Hartz; treasurer, H. B. Best.

CHARLESTON, S. C.—The extensive system of the Gordon Telephone Company, of Charleston, has been bought out by the Southern Bell Company and the two interests will be merged as soon as possible. The Gordon Company, it is said, desired to sell. The price paid, while small, was sufficient to meet all obligations of the Gordon Company, of which M. C. Duncan will remain in charge.

NASHVILLE, TENN.—The Cumberland Telephone & Telegraph Company is seeking permission to place its wires underground in the business portion of the city.

DENTON, TEX.—The People's Home Telephone Company has just completed the installation of its new exchange at Denton and will begin operations with about 250 telephones in a few days.

AUSTIN, TEX.—The Comptroller of Public Accounts of the State of Texas has taken steps looking to the enforcement of the law requiring all telephone companies operating in that state to pay an annual tax on each telephone instrument in use. It is conservatively estimated that there are fully 250 telephone companies operating in Texas. Of this number only 29 have complied with the law requiring the payment of taxes on the telephones which they had in operation on January 1, 1904.

SALT LAKE CITY, UTAH.—At the recent meeting of the stockholders of the Rocky Mountain Bell Telephone Company a report was submitted showing an increase in business of 25 per cent. over the previous fiscal year. The net gain reported was $215,042.73. The present board of directors was re-elected with the exception of Charles W. Clark, whose place was filled by the selection of Governor B. F. White, of Montana.

WINCHESTER, VA.—The Southern Bell Telephone Company has secured a franchise at Winchester, paying $250 therefor.

MONROE, WIS.—The Monroe Telephone Company has increased its capital stock from $20,000 to $50,000.

GLIDDEN, WIS.—The Glidden Telephone Company has been incorporated with a capital stock of $24,000 by J. R. Whittaker, W. L. Schuppert, E. B. Gordon, David Bodway, J. W. Hoops and George L. McCurdy.

MILWAUKEE, WIS.—It is stated that the Independent Consolidated Telephone Company will establish an exchange in this city within a year. It is calculated that an adequate system will cost over $1,000,000, but the company, it is stated, is prepared to go ahead with the work.

TLANALPAN, MEX.—A telephone line is being constructed from Tlanalpan to the town of Tepeapulpo.

CULIACAN, MEX.—The Government of the State of Sinaloa has granted a concession to Antonio Echevarria to establish a telephone system in the Mocorinto district of the state. All the principal towns and villages in the district will be connected by long distance lines.

MONTREAL, QUE.—At the annual meeting at Montreal on February 25 of the shareholders of the Bell Telephone Company of Canada, the directors were authorized to issue $2,000,000 new stock at $125, in five installments of $25 each. This will bring the capitalization up to $8,000,000. The additional capital is required for line extensions and general additional equipment to keep up with the rapid growth of the country. The annual report of the company shows that 8,691 subscribers have been added to the list during the past year. The total number of instruments now earning rental in the Dominion is 57,172. The company now owns and operates 421 exchanges and 672 agencies. About 4121 miles of wire were added to the long distance system in 1903, and the long distance lines now opened and operated by the company comprise 30,969 miles of wire on 7685 miles of poles.

ELECTRIC LIGHT AND POWER.

EAST LAKE, ALA.—The citizens of East Lake will vote on March 28 on the question of issuing $13,500 bonds for an electric lighting plant.

ANNISTON, ALA.—The Anniston Stove Works Company is to build a $50,000 plant which will be probably operated by electric power, each machine having an independent motor. Mr. O. W. Snyder is manager.

GILROY, CAL.—The Council is considering the establishment of an electric light system.

SEBASTOPOL, CAL.—G. W. Swain has petitioned for a franchise to establish a light and power plant.

SAN FRANCISCO, CAL.—The California Gas & Electric Company on February 29 absorbed the Standard Electric Company and United Gas & Electric Company. The company has more than 1100 miles of line and it sends power to many cities within a radius of 250 miles of San Francisco.

LOS ANGELES, CAL.—The Union Power Company has been incorporated with $2,000,000 capital, $15,000 paid in, to produce electric light, power and heat by the utilization of the waters of the Santa Ana River. The directors are: J. B. Miller J. C. Drake, A. C. Balch, F. Forman and Kaspare Cohn, of Los Angeles, and J. S. Torrance, of Pasadena.

GEORGETOWN, CAL.—Negotiations are reported under way with the American River Electric Company to extend a line from a point near the Delmatia Mine, in the Kelsey district, to Georgetown for power and lighting purposes. The line will be about 9 miles in length. Superintendent Everson, of the El Dorado Copper Mining Company, is at the head of the movement.

WASHINGTON, D. C.—A bill has passed the United States Senate authorizing the Minnesota Power Company to construct a dam across the Mississippi River between Wright and Sherburne Counties, Minnesota.

PENSACOLA, FLA.—Bids are wanted for $50,000 water, light and ice factory bonds. Address P. O. Box 632, Pensacola.

HIGH SPRINGS, FLA.—The Council has under consideration the matter of issuing bonds for water works and an electric light plant.

BERN, IND.—H. H. Stucky has petitioned for a franchise for an electric light plant.

FT. WAYNE, IND.—The Ft. Wayne Electric Light & Power Company is considering plans for a power plant.

SOUTH BEND, IND.—The Oliver Chilled Plow Works, of South Bend, will run its power wires underground from the new power plant to the factory, requiring about 6000 feet of conduit.

INDIANAPOLIS, IND.—The Board of Public Works has awarded the contract to light this city for the next ten years to the Indianapolis Light & Power Company, which was the lowest of the three bidders. The contract price is $75 a year for each light on both direct and alternating-current enclosed arc lamps, and $74 on direct-current open arc lamps. The company also bid $35 a year on 50-cp incandescent lamps. The competitive bids were made by George E. Fisher, of Detroit, and E. C. Bruckman, of New York, who bid $78.50 on arc lamps, $32.50 on incandescent lamps, $83.82 on the alternating-current enclosed arc lamps and $26.25 for the 50-cp incandescent, respectively. The former price paid to the successful company was $85 a year for each light on a moonlight schedule. The new contract is for an all-night schedule.

SAPULPA, I. T.—It is reported that an electric light plant will be constructed here, at a cost of $27,500.

LENOX, IA.—The Town Council has granted a 25-year franchise to S. E. Wainright to construct and operate an electric light plant, to cost about $7000.

ANNAPOLIS, MD.—A bill has been introduced in the State Senate incorporating the Towson Electric Co.

KENSINGTON, MD.—A bill has been introduced in the State Legislature to authorize this city to issue bonds for water works and an electric light plant.

GLADSTONE, MICH.—The Village Council has granted a franchise to local parties for an electric light plant.

GOBLEVILLE, MICH.—The matter of issuing $20,000 bonds for municipal water works and a lighting plant is under consideration.

MERIDIAN, MISS.—The Meridian Light & Power Company will increase its capital stock from $750,000 to $1,000,000.

ABERDEEN, MISS.—The Aberdeen Electric Light & Power Co., of Aberdeen, has been incorporated with a capital of $15,000, by E. M. Jones, J. R. Jones, C. C. Tubbs and others.

ST. LOUIS, MO.—The Laclede Power Company, of St. Louis, has won its fight with the City Water Department on the question of its right to draw its own water from the Mississippi River.

SEDALIA, MO.—It is reported that Mayor Babcock will soon lay before the City Council plans for an electric light plant, and will recommend that it be built, and the contracts at present existing not be renewed.

LIBBY, MONT.—Bids will probably be received in July for an electric light plant, to cost about $6000.

PENN YAN, N. Y.—Horace B. Smith is at work on plans and specifications for a municipal electric light plant.

VICTOR, N. Y.—The Rochester & Eastern Railway Company has submitted a proposition to the Village Board to furnish incandescent lights for both public and private use.

PENFIELD, N. Y.—The business men and citizens are interested in the construction of an electric light system. It is proposed to procure the current from the plant at Lincoln Mills.

LOCKPORT, N. Y.—A resolution has been passed by the Common Council directing an election on the proposition to install a municipal electric light plant, at a cost not to exceed $50,000.

SODUS, N. Y.—Two applications have been made to the Town Board of Trustees for franchises for an electric light plant. One from Omar Curtis, of Wolcott; the other from the Sodus Gas & Electric Light Company, recently formed.

BROOKLYN, N. Y.—Bids will be received until March 14 by C. B. J. Snyder, superintendent of school buildings, New York City, for installing electric light wiring, fixtures and electric bell system in School No. 47, Borough of Brooklyn.

NEW YORK, N. Y.—Bids will be received March 15 at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., for furnishing the navy yard here a quantity of electric motors, motor-generators, generating sets, conduits and fittings, wire, wiring appliances, incandescent lamps, electric light fixtures, copper pipe, brass fittings, valves, etc. H. T. B. Harris, Paymaster-General, U. S. N.

NEW YORK, N. Y.—Commissioner John T. Oakley, of the Department of Water Supply, Gas and Electricity, has advertised for bids for the city lighting for a year from March 16. This includes the lighting of streets, parks and public buildings by both gas and electricity, and in advertising for contracts dated from March 16 instead of dating back to Jan. 1 the city officials let it be known that they will let the companies continue their fight in the courts for payment for the light supplied in 1903 and up to March 15 of the current year. The lighting appropriation for last year amounted to $3,306,346.

GOLDSBORO, N. C.—It is proposed to increase the capacity of the electric light plant. Address C. Dewey, chairman of the Board of Public Works.

CHARLOTTE, N. C.—W. S. Lee, Jr., of Rock Hill, S. C., vice-president and chief engineer of the Catawba Electric Power Company, of Rock Hill, S. C., writes that it is proposed to construct a sub-station at Charlotte, and to build 18 miles of high potential transmission line.

FARGO, N. D.—The Union Light, Heat & Power Company will improve and enlarge its plant.

DRAYTON, N. D.—John R. Hogg is interested in the construction of an electric lighting plant.

WEST MANSFIELD, OHIO.—Bids are wanted April 1 for $11,000 electric light bonds. C. D. Atkinson is clerk.

BELLEFONTAINE, OHIO.—The Board of Public Works has had plans prepared for a municipal lighting plant to cost $60,000.

CONNEAUT, OHIO.—The city will make some improvements to its electric light plant. Some pumping machinery will also be installed.

WAPAKONETA, OHIO.—The Village Council will issue $7000 worth of 5 per cent. bonds for the purpose of enlarging and improving the village lighting plant.

CARDINGTON, OHIO.—The Cardington Electric Light & Power Company, capital $15,000, has been incorporated by G. M. Schambs, J. W. Glauner, W. P. Vaughan and others.

SALEM, OHIO.—J. S. Kleinfelter, of the proposed Salem Electric Light, Heating & Ice Company, states that a location for the plant has been secured and that the ice and electric lighting plant will be in operation about June 1.

WILKESBARRE, PA.—Mayor Price has signed the bill granting a franchise to the Ashley Electric Light Company. The ordinance granting a franchise to the West Side Electric Light Company has been reconsidered by the Council and passed on final reading.

SOUR LAKE, TEX.—It is reported that another electric light and power plant is to be installed here. D. O. Lively can probably give information.

AMERICAN FORK, UTAH.—The local electric light company will build a line to the pumps on Jordan River. The capacity of the plant is being greatly enlarged.

EAST MILWAUKEE, WIS.—The residents of the scattered village of East Milwaukee are concerned in the move by the Milwaukee Light, Heat & Traction Company to secure a franchise for lighting the village with 18 electric arc lights at $84 per year for each light, the same proposition as was made to West Allis. As East Milwaukee is a country settlement, and there are not a half dozen houses near together in the village, which embraces all of the town of Milwaukee between the lake and the river, and from the northern city limits at Keefe Ave. to the southern limits of Whitefish Bay, some of the residents object to electric lighting as something not needed.

SAN LUIS POTOSI, MEX.—The Governor of the State of San Luis Potosi has called for bids for a municipal electric light and power plant for this city.

MONTEREY, MEX.—The Monterey Electric Light & Power Company has given an order to the General Electric Company for a steam turbine and electrical equipment for the plant in this city.

MONCLOVA, MEX.—The City Council of Monclova has awarded the contract for the installation of an electric light and power plant at this place to Victor M. Braschi & Bro., of the City of Mexico. The plant will cost about $100,000 gold.

PUEBLA, MEX.—The Mexican Government has granted a concession to Archbishop Gillow, of Puebla, for the construction and operation of an electric light and power plant on his Chiautla hacienda, situated in this state. Water power will be used to generate the electrical energy.

KINGSTON, ONT.—Cable advices from London, Eng., announce that the city of Kingston has won before the Imperial Privy Council in the appeal of the Light, Heat & Power Company. This case has been before the courts for over two years. In 1901, the arbitrators fixed the value of the company's plant, which the city is taking over, at the sum of $170,373. They decided that there was no franchise, and left the company to appeal to the courts upon that point. If there could be shown to be a franchise, then the value was fixed at $80,000. The company appealed first to the high courts in Canada, and finally to the Privy Council of Great Britain. All the appeals were decided against the company, and now the city gets the plant at the arbitrators' award of $170,373, less a sum to be fixed for depreciation since 1901.

THE ELECTRIC RAILWAY.

BESSEMER, ALA.—The Birmingham Railway, Light & Power Company, it is said, will take up the matter planned some time ago, to construct a suburban railway to Jonesboro.

ARKANSAS CITY, ARK.—The contract for the building of the Interurban Railway between this city and Winfield and between this city and the Indian schools at Chilocco, Okla., has been awarded to a St. Louis company. It is expected that the work will cost between $500,000 and $650,000. The power house, general offices, etc., will be in Arkansas City. Mr. L. H. Northrup is the promoter.

SAN FRANCISCO, CAL.—The United Railroads of San Francisco has asked permission to reconstruct as an electric road the steam road which extends from the Cliff House.

LOUISVILLE, KY.—The Louisville Railway Company directors recently re-elected the present officers, as follows: T. J. Minary, president; St. John Boyle, vice-president and general counsel, and Samuel G. Boyle, secretary and treasurer. The annual statement shows nearly $2,000,000 gross earnings. During the past year an underground conduit system has been begun, a large addition to the power house has been made and the construction of the three suburban lines has been pushed as rapidly as possible. Three sub-stations for these lines have been erected. Bonds to the extent of $210,000 were sold.

DULUTH, MINN.—The Duluth Street Railway Company will probably install an air or electric hoist in its new repair and paint shops, as well as a few small machine tools.

ST. PAUL, MINN.—A bill is before Congress granting permission to the Minnesota Power & Trolley Company to construct a dam across the Mississippi River two miles above Elk River, 950 feet long, which it is estimated will develop from 15,000 to 20,000 horse-power. This is to be used primarily for trolley lines, and the surplus for commercial purposes. An interurban and a belt line is contemplated.

MERIDIAN, MISS.—The "Jim Crow" law recently enacted in Mississippi has severely hurt the street railway business in this state. There are but 28 miles of electric railway in the entire state, of which seven are in Meridian. The law compels the street car companies within 90 days either to provide separate cars for the colored people, or to place portable screens in the cars to separate them from the white passengers. The law will have a tendency to stop further street railway extensions and improvements contemplated.

SUMMIT, N. J.—The Cross Steam & Electric Railway Company, which is believed by many to be the successor of the new Orange Railway Company, which about a year ago purchased considerable property through the eastern section of Summit for a railway line and later abandoned the project, has made application to the Summit Common Council for trackage rights in several Summit streets. The company proposes to connect Summit and Elizabeth by a steam railroad. Louis Keller, organizer of the Baltusrol Golf Club, signed the application. In the application it is set forth that all necessary rights of way through private property had been purchased, and should Summit grant the trackage rights asked for the company would agree to begin the work of construction of the line early during the coming summer.

NEW YORK, N. Y.—Proposals will be received by the Cienfuegos, Palmira & Cruces Electric Power & Railway Company, at its office, Havana, Cuba, or at the office of its consulting engineer, C. C. Vermeule, 203 Broadway, New York, until March 15 at noon, for the following material, delivered f. o. b. ship in the harbor of Cienfuegos, Cuba: 4400 tons of steel T-rails, 70 lbs. per yard; 1200 kegs of spikes, 14,100 (0000) electric rail bonds, 105,000 creosoted railroad ties, 4100 trolley poles, 15,000 barrels Portland cement. Specifications for the above material will be furnished at either of the above offices. Proposals will also be received for grading, bridges, culverts, track-laying, etc., for 39 miles of railway between Cienfuegos, Cruces and Cumanayagua; also for constructing a dam, 4000 ft. of tunnel, a flume, and power house on the Rio Hanabanilla, with an auxiliary dam on the Rio Negro, and clearing about 2200 acres of reservoir lands. Plans, specifications and quantities for the above construction work will be furnished by F. W. Bennett, chief engineer, 128 Calle San Carlos, Cienfuegos, and bidders for construction must inspect the location of the work.

CLEVELAND, OHIO.—The holdings in the Cleveland Electric Street Railway Company of the late Marcus A. Hanna are stated to be worth about $2,000,000.

DAYTON, OHIO.—John H. Boroff, representing the Interstate Traction Company, has applied to the Montgomery County Commissioners for a franchise for an electric railway from Dayton to Indianapolis.

COLUMBUS, OHIO.—The Columbus, Buckeye Lake & Newark Traction Company is preparing to make $10,000 worth of improvements at Buckeye Lake, but it has given up the plan of building a new hotel at the resort.

COLUMBUS, OHIO.—The Findlay, Forest & Marion Railway Company, of Columbus, has been incorporated with $10,000 capital stock. Incorporators are: Claude Meaker, W. B. Beebe, H. E. Armbruster and W. B. Earnhart.

MANSFIELD, OHIO.—The Mansfield & Mt. Vernon Traction Company, with a capital stock of $10,000, has been incorporated by Wm. W. Branyan, A. B. Beverstock, Mark H. Arnold, E. R. Rumpler, W. A. Hambleton, Frank Fairchild and C. G. Cooper.

CINCINNATI, OHIO.—The Cincinnati Suburban Belt Line and the Cincinnati, Chester Park & Red Bank Belt Line have practically agreed on terms of consolidation. Thomas P. Egan, of the Fay & Egan Company, has been tendered the presidency of the consolidated company.

DAYTON, OHIO.—The Dayton & Muncie Traction Company has elected these officers: J. E. Lowes, president; A. Newsalt, vice-president; J. E. Feight, secretary; W. B. Gebhart, treasurer. The road is under construction from Greenville, O., to Muncie, Ind., and will probably be completed by August.

YORK, PA.—It is proposed to petition the Maryland & Pennsylvania Railroad Company to change the motive power on its line from steam to electricity.

YORK, PA.—Nearly all the rights of way have been promised for an extension of the York County Traction system from Red Lion to Airville.

HARRISBURG, PA.—The Wilkins & Braddock Electric Street Railway Company has been chartered to build an electric railway 3½ miles long in Allegheny County. The capital stock is $21,000.

HARRISBURG, PA.—The Valley Traction Company has begun work on the enlargement and improvement of the Bridgeport power house. A new boiler house is being built and an extension added to the present plant. When completed the capacity of the plant will be more than doubled. The boiler house will be 100x40 ft., and equipped with five Babcock & Wilcox high-pressure boilers. The extension to the main building will be 30 ft. long.

BLOOMSBURG, PA.—The Danville & Bloomsburg Street Railway Company has given out contracts as follows: For boilers and engines, to the E. Keeler Company, of Williamsport; generators, to the Crocker-Wheeler Company, Ampere, N. J. The power house will be built at Grovania. At a recent meeting of the company further arrangements were made for the early commencement of work on the new 12-mile line. The contract for building the line has been awarded to the Standard Construction Company, of Allentown.

NASHVILLE, TENN.—At the annual meeting of the stockholders of the Nashville Railway & Light Company all of the former officers and members of the board of directors were re-elected.

KNOXVILLE, TENN.—The Knoxville Street Railway & Electric Light Company has been sold to Ford, Bacon & Davis, of New York. It is stated that extensive improvements will be made in the near future.

EL PASO, TEX.—It is announced that interests closely identified with the Union Traction Company, of Indianapolis, Ind., will build an electric interurban railway from El Paso to Las Cruces, New Mex.

TEMPLE, TEX.—The Pennsylvania men who contemplated building an interurban electric railway between this place and Belton have abandoned the project after making a personal investigation of the situation.

SALT LAKE CITY, UTAH.—The Salt Lake & Brigham City Electric Railway Company has been granted a franchise to construct its proposed electric system through Davis County. The road will connect Salt Lake and Ogden. It will eventually be extended from Ogden to the northern boundary of the State.

NORFOLK, VA.—The Norfolk Railway & Light Company and the Norfolk & Atlantic Terminal Company have discontinued their service to Old Point on account of lack of patronage. The schedule to Old Point may be resumed later.

COLFAX, WASH.—A franchise has been granted to the Palouse & Spokane Electric Railway Company by the County Commissioners for the construction of its system from Spokane to this city and from here to Penawawa, in the extreme east of the State. The company has already done considerable grading for the proposed road.

WHEELING, W. VA.—It is stated that the Wheeling Traction Company has awarded Coulter & Furtwangler the contract for the extension of its lines from Pasco to Barton.

HUNTINGTON, W. VA.—The Huntington & Charleston Railroad Company has been chartered with $20,000 capital, to build a steam or electric road between these cities. W. R. Thompson, E. M. Eatts and others, of Huntington, are the incorporators.

WAUPACA, WIS.—The Waupaca Electric Light & Railway Company, which owns and operates a five-mile street and interurban railway and an electric lighting plant at Waupaca, has just held its annual meeting and elected the following officers: President and general manager, Irving P. Lord; vice-president, W. H. Lord; secretary, John D. Caughell; treasurer, P. M. Olfson. These gentlemen, together with J. W. Evans, constitute the board of directors. The total income of the company for 1903 was $18,092.68; operating expenses, including taxes, insurance and maintenance account, $8366.06; interest on bonded indebtedness, $2040; showing net earnings for the year of $7686.62, or a trifle over 10 per cent. on the capital stock of $75,000. The company has increased its capital to $125,000 and intends to make some extensions this spring.

OTTAWA, ONT.—It is announced officially that the Ottawa & New York Railway, operating between Ottawa and Tupper Lake, N. Y., is to be converted into an electric road during the current year.

WATERLOO, ONT.—A company now seeking incorporation asks for permission to build an electric railway from Wellesley, in Waterloo County, via Stratford and St. Marys to Clinton, thence in a southwesterly direction to Bayfield.

OTTAWA, ONT.—The incorporation of a company to build an electric railway from Brantford to Hamilton, Ont., will be sought from the Dominion Parliament at its approaching session. Authority will also be asked to permit the company to convey electrical power over the right of way, and to sell and distribute the same within the municipalities traversed by the line.

OTTAWA, ONT.—According to the official returns of the department of railways and canals for Canada, just issued, giving statistical information for the past fiscal year in respect to railways in Canada, it is shown that the mileage of electric railways in Canada was 759, as against 558 in the previous year. In addition to this there were 32 miles of sidings. The gross earnings of electric railways totalled $7,223,677, as against $6,406,438 for the previous year. The net earnings were $2,760,819. There were also large increases in the number of passengers and freight carried. Last year there were 155,662,812 passengers carried and 371,182 tons of freight moved.

MONTREAL, QUE.—A party of engineers is now locating the route of the new Montreal-Ottawa Electric Railway.

QUEBEC, QUE.—Hon. John Sharples, J. Bell Forsyth, A. C. Dobell and others purpose forming a company with a capital of $100,000, to connect the parishes of St. Colomban, Sillery, Bergerville and Charlesbourg with the city of Quebec by means of an electric railway.

LEGAL.

SWITCHBOARD SUIT.—The Western Electric Company has brought suit against the Rochester Telephone Company, of Rochester, N. Y., based on the allegation that the Rochester Company's switchboard is an infringement on a patent controlled by the Western Electric Company.

WHAT IS A CORPORATE GIFT?—Charles C. Worthington has been sued by the corporation of Henry R. Worthington, of which he was president until November, 1900, for $12,570, the cost of the scientific apparatus which Mr. Worthington in 1897 presented to the School of Mines of Columbia University as a memorial to his father, the founder of the firm. The corporation, with which Mr. Worthington has severed his connection altogether, claims that he ordered the apparatus—consisting of steam pump machinery and various auxiliaries—agreeing to pay for them. Mr. Worthington denies any personal liability for the material and apparatus. He contends that they were presented as a corporate gift, and that the firm is liable for the cost.

HORSE AS A MISSILE.—New York Supreme Court Justice Nash has decided that a street railway company is not necessarily liable if a horse, belonging to somebody else, pokes its head through a car window and injures or frightens any of the passengers. The decision arose out of the suit brought by Christine T. Grant against the Metropolitan Street Railway Company to recover for injuries she sustained in just such an accident about a year ago. She was riding in a Fourth Avenue car, which stopped suddenly at Twenty-third Street. A horse that was crossing Twenty-third Street was going too fast to be stopped in time, and its head crashed through the window where Miss Grant was sitting. She was struck by flying pieces of glass and suffered from shock. She held that the company was necessarily liable, but Justice Nash holds that where, as in this case, the accident is the result of contact with some object over which the company had no control, the legal status is just the same as if Miss Grant had been injured by a flying missile thrown at the car.

CUTTING TREES FOR WIRE STRINGING.—The Supreme Court of Iowa has recently held that the measure of damages for unreasonable cutting of trees for the erection of a telephone line is the difference between the value of the land as it would have been if the cutting had been reasonable and what it was after the cutting, not the difference between the value before and after the cutting. In a case recently before the Supreme Court of Wisconsin, a somewhat similar point was up in regard to the Waukesha Electric Light Company. It appeared that Revised Statutes 1898, sections 925-88, applicable to cities of a certain class, provides that the time "and manner" of using streets for placing electric light poles "shall" be determined by the Board of Public Works, subject to review by the Common Council. An ordinance granted an electric light company the privilege of using the streets, subject to the direction and supervision of the Board of Public Works, in the setting of poles, etc. The board made an order authorizing the use of certain streets, but not designating any particular places where poles should be put. The Supreme Court held that the company had no right to set a pole in front of an abutting owner's property, so as to require the trimming of his shade trees, without his consent.

OBITUARY.

MR. ANDREW HOWARD, president of the Phœnix Glass Company, died Feb. 27 at Wilkinsburg, Pa., of pneumonia, after an illness of ten days. Mr. Howard was born in Pittsburg in 1837, and started life as a clerk with the transportation firm of Clark & Thaw, which afterward was merged in the Star Union Line, Mr. Howard becoming cashier of the latter. He resigned this position in 1880 to organize the Phœnix Glass Company, for the manufacture of a patent glass insulator, which product, however, was abandoned and the manufacture of lamp chimneys taken up. From this beginning, and principally through Mr. Howard's enterprise and energy, the Phœnix Glass Company steadily progressed to its present large proportions. Mr. Howard enjoyed great popularity among his numerous employees, an evidence of which were the lavish floral offerings from these at the funeral.

MR. JOHN S. KING.—Mr. John S. King, treasurer of the David Williams Company, of this city, died on March 4 at his home in Brooklyn. He was born at Middletown, N. Y., in 1841, and learned the trade of a printer there. He went to the front in the civil war as a private in the Eighteenth New York Regiment, and was seriously wounded by one of the last shots fired in the battles before Richmond, immediately before the surrender of that city. He was acting adjutant of his regiment at the time. In 1898 he was made treasurer of the David Williams Company, and continued as business manager of *The Iron Age, The Metal Worker* and *Carpentery and Building*. He was also made treasurer and general manager of the Williams Printing Company upon its organization. Mr. King was a member of a great many Masonic organizations and of the Sons of American Revolution, Grand Army of the Republic, Loyal Legion, Society of the Army of the Potomac, Hardware Club and the Union League and Aurora Grata Clubs of Brooklyn. Mr. King is survived by his wife, who was Miss Gertrude Murray, of Hudson, O., and six children. The funeral services were held from his late residence.

MR. J. D. EASTERLIN.—We regret to note the death of Mr. John D. Easterlin, the special agent of the Southern Bell Telephone & Telegraph Company, this sad event taking place at Marietta, Ga., after a short illness, on February 17. His illness began with a slight earache, but his condition rapidly became more serious and he succumbed in a few days to mastoiditis. He was born at Bamberg, S. C., June 21, 1844, and began his electrical career as a telegraph operator, becoming at an early age manager of the office at Charleston, S. C. He was for many years manager for the Southern Bell Telephone & Telegraph Company in the same city and afterwards district superintendent there, as well as at Macon, Ga. In 1890 he went to Atlanta, occupying the same position, but for the last five years larger responsibilities had been put upon him and he had been made special agent to assist the general manager of the company. In this work his long experience, sound judgment, indefatigable industry, and genial manners, secured him success which rounded out his long career of usefulness. His death is greatly felt by his old friends and associates. Mr. Easterlin was deacon in the Jackson Hill Baptist Church of his city, and was also a Royal Arch Mason. He leaves behind him a wife, two sons and one daughter, and two grandchildren. The funeral services were held in Charleston, S. C.

PERSONAL.

FIRST LIEUTENANT F. E. LYMAN, JR., has resigned from the U. S. Signal Corps, to take effect March 25.

MR. LOUIS ALBERGER, of the Alberger Condenser Company, Liberty Street, New York, has returned from a three weeks' trip to Cuba.

MR. JOHN S. LAPP, secretary and treasurer of the Locke Insulator Manufacturing Company, Victor, N. Y., was a recent visitor to New York.

MR. CHARLES E. LAWRENCE has become president of the Charlestown, Mass., Gas & Electric Company, in the place of Mr. J. P. Hunnewell, who has resigned.

MR. A. C. RAHE, of the Smith Storage Battery Company, Binghamton, N. Y., was in New York City recently, accompanied by Col. E. H. Hewins, of Boston.

MR. S. G. McMEEN, the telephone expert, has returned to Chicago after completing the preliminary work of mapping Mexico City for the new underground telephone system.

MR. HENRY M. WATSON, formerly president of the Buffalo Railway Company, has been re-elected president of the Bell Telephone Company of Western New York, with headquarters in Buffalo.

MR. W. K. PALMER, M. E., consulting engineer, Kansas City, Mo., has moved his office in that city to Suite 402, Lyceum Building, where he will give attention to lighting and power plants, etc.

MR. MARIUS LATOUR, the well-known French electrical engineer, is now visiting this country, as to his inventions. This journal has recently published one or two communications from him on the subject of his work.

MR. ROBERT T. E. LOZIER, for some time past so prominently connected with the Bullock Electric Manufacturing Company, in charge of its sales department, has resigned in order to engage in electric motor work on his own account.

MR. J. B. COWEN, of the General Incandescent Arc Light Company, has recently returned from an eight months' business trip to Europe, and has assumed charge of the sales department of the above named company in New York.

MR. T. W. CROWLEY has been appointed superintendent of telegraph of the Delaware & Hudson Railroad Company to succeed Mr. J. W. Burdick, who will henceforth devote his entire attention and time to the duties of general passenger agent.

MR. A. KENNEDY ASHWORTH has resigned as assistant manager of the Underfeed Stoker Company, Chicago, to accept the New England agency of the Buckeye Engine Company, Salem, O., with headquarters in the Hancock Building, Boston, Mass.

MR. H. HINE, formerly of the Stanley interests and now president of the Guanajuato Power & Electric Company, which is to considerably extend its operations in Mexico, has left New York for Colorado Springs. He expects to return in about a fortnight.

MR. WALTER ABBOT, one of the directors of the London United Tramways, now controlled by the Underground Electric Railways Company of London, Ltd., of which Charles T. Yerkes is chairman, is now on a visit to this side. He is at present in Boston.

MR. A. J. WURTS, manager and engineer of the Nernst Lamp Company, has been seriously ill for some time past at Pittsburg, and had to go to Atlantic City to recover his strength. We are glad to report that he has now returned to work and has entirely recovered.

MR. W. W. KER, of the Hebrew Technical Institute, is delivering for the New York Board of Education at the Alfred Corning Clark Neighborhood House, another course of free lectures, beginning March 1, devoted to the principles and practice of electrical engineering. There will be eight of the lectures.

MR. WILLIAM T. BENALLACK, of Detroit, Mich., is delivering a course of lectures before the Indiana underwriters' and electrical contractors on "Faulty Wiring." The speaker is president of the National Electrical Inspectors' Association, as well as the head of the electrical inspection of the Michigan Board of Fire Underwriters.

MR. GEORGE WESTINGHOUSE is the theme of a most interesting and very ably written article in the New York *Times* of March 5, by Mr. Arthur Warren, who has studied his subject at close quarters, and has all the qualities needed by a biographer. It is a fine revelation of a great and fascinating personality—of a really great American.

MESSRS. G. C. HENRY and WALTER CASTANEDO, of Atlanta, Ga., who represent the southern interests of the Bullock Electric Manufacturing Company and the Harrisburg Foundry & Machine Works, respectively, are now in New York with a view to closing contracts for the equipment of a 900-hp lighting and railway plant to be built in Florida.

MR. C. P. BRUCH, assistant secretary and assistant general manager of the Postal Telegraph-Cable Company, has received recently a fine gavel as chairman of the conference of officials of that company, from his colleagues, members of the conference. The woods are varied and choice, including a handle made very appropriately from an olive branch.

DR. MAX VON RECKLINGHAUSEN, who has been associated with Nernst and Cooper Hewitt lamp development in this country, has gone to Europe to establish a Cooper Hewitt factory there, so as to meet the demand which has already been created for the lamp. It is hoped that at no distant date the Doctor will return to a country where he has made so many friends.

MR. L. D. GARDNER, recently of the New York *Sun*, and an active member of the Technology Club of New York, has organized the L. D. Gardner Company at 521 Temple Court, this city, to build up a business in radium specialties of all kinds. He has lately been giving attention to the matter, and is the coiner of the phrase "liquid sunshine," as applied to fluorescent liquids, which has so caught the public fancy.

MESSRS. GEORGE BULLOCK, president, and Joseph S. Neave, vice-president, of the Bullock Electric Manufacturing Company, of Cincinnati, are now in New York. They came east primarily for the purpose of attending the special meeting of the stockholders of the company, which will meet in Jersey City, March 16, to ratify the Allis-Chalmers-Bullock deal, to which reference is made elsewhere in this issue. They are guests at the Gregorian Hotel, West 35th Street.

MR. RICHARD E. SACK, formerly of the editorial staff of the ELECTRICAL WORLD AND ENGINEER at the Chicago office, has recently accepted the position of contract agent for the Albert Lea Light & Power Company, Albert Lea, Minn. Mr. Sack will devote his energies to building up the business of this company, especially in the direction of increasing the number of electric motors in use, and securing customers for the new gas plant which the company is just starting. His engineering training and ability should stand him in good stead.

SIR WEETMAN D. PEARSON, Bart., M. P., chairman of the British contracting firm of S. Pearson & Company, Limited, which is undertaking some huge contracts in Mexico entailing the purchase of considerable electrical equipment in the United States, is now in New York en route for England. He is president of the Ferrocarriles de Veracruz, Limitada, which operates some 12 miles of horse tramways in Vera Cruz, Mex. These lines are to be converted to electricity and extended. Sir Weetman is a guest at the Waldorf-Astoria. He expects to remain here for about a week.

MR. P. FARNSWORTH.—Mr. Philip Farnsworth, formerly of New Haven, Conn., has removed to 150 Nassau Street, New York City, where he will continue the practice of general patent law. He has been retained as counsel in several important patent suits. He has had an unusually valuable experience in the practice of patent law, having been associated for several years with Mr. F. H. Betts. Previously, Mr. Farnsworth acted for several years as local counsel at Schenectady for the General Electric Company. He graduated from the Sheffield Scientific School in 1894, and from the Yale Law School in 1897, after which he practiced in Washington, D. C.

MR. HARRY D. PARSONS, who has been superintendent of construction and electrician for the Meridian, Miss., Light & Railway Company, has resigned from that company to accept a position of salesman for the Commercial Electrical Supply Company, of St. Louis, Mo. It may be recalled that Mr. Parsons about five years ago figured in newspaper accounts as the victim of an accident from a 10,000-volt transmission circuit in Texas, being so badly burned that he had to undergo the operation of having almost 300 square inches of flesh grafted upon his body from other people's bodies. The medical journals at that time stated that this was the most successful piece of skin grafting ever accomplished.

MR. W. G. LEVISON.—The March meeting of the New York Mineralogical Club will be held on Wednesday, March 16, 1904, at the residence of Mr. Wallace Goold Levison, 1435 Pacific Street, corner of Brooklyn Avenue, Borough of Brooklyn. The following will speak: Dr. George F. Kunz—"Further observations on substances that respond by phosphorescence to natural radioactive substances," with exhibition of "Actinium"; Mr. George L. English—"Exhibition and description of some twin calcite crystals from a new find at Joplin, Mo." Mr. Levison will exhibit a series of specimens of fluorescent Willemite from Franklin, N. J.; radioactive pitch blende from Bedford, N. Y., and minerals from New York City and other selections from his collection.

MR. B. A. BEHREND, chief engineer of the Bullock Electric Manufacturing Company, is visiting New York this week. In the recent combination of the Allis-Chalmers and Bullock interests, Vice-President W. J. Chalmers has retained and secured the services of Mr. B. A. Behrend as chief electrical engineer. Mr. Behrend's successful work during the past four years in the design of some two hundred thousand kilowatts of large alternating and direct-current machines, has established the engineering reputation of the Bullock Company as a factor in the building of electric power plants of the largest size. Among the more notable designs of Mr. Behrend are the municipal plant at Nashville, Tenn.; 5000 kw. of alternating-current generators in Denver, Col.; five 5000-kw generators for the Kern River Power Company, California; the generators for the Pacific Electric Railway Company, Los Angeles; the generators for the Mutual Electric Company, San Francisco; the frequency changers in Montreal, representing 10,000 kw, and numerous other plants of note and interest. The 3500-kw generating unit which will be exhibited by the Allis-Chalmers and Bullock companies at the World's Fair at St. Louis, the largest power unit at the Exposition, was also designed by Mr. Behrend, whose work has also found recognition outside his immediate sphere of activity. Only 29 years of age, he is a full member of the Institute, a member of the Committee of Standardization, chairman of the Cincinnati Branch of the Institute, a fellow of the American Association for the Advancement of Science, and a member of the Advisory Committee, appointed by President Francis, of the International Electrical Congress. Mr. Behrend's treatise on "The Induction Motor" has been translated into French and German, and he has lectured at the universities of Wisconsin, McGill and Leland Stanford.

Trade Notes.

EXHAUST HEADS.—A large plate glass factory at Alexandria, Ind., has placed an order with the Burt Manufacturing Company, Akron, O., for three 16-inch exhaust heads.

MICA INSULATOR COMPANY, Chicago and New York, has issued recently its 1904 price list of micanite, linotape, Empire cloths and papers, "M. I. C." compound, etc. The list goes into details of parts for a wide range of well-known apparatus.

THE ELYRIA ENGINE COMPANY, Elyria, Ohio, has purchased a site in that city and will erect a new plant to cost $100,000. The main building will be 75x175 feet. The company manufactures gas engines. Heman Ely, of Elyria, is at the head of the company.

STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY has issued a tasteful and striking folder as to its dry core lead-covered telephone cables, which it makes exclusively for independent telephone companies, in addition to its other wires, cords, cables, etc.

NEW THINGS.—The "New Discoveries in Electricity" which have opened before men new vistas of human possibilities, are described in an 8-page article in *The Living Age* for Feb. 27, with such clearness that even the unscientific reader will find no difficulty in appreciating them.

AL-LECTRO.—The L. B. Allen Company, Inc., Chicago, is handling Al-lectro, which is a polish for gold, silver, nickel, brass, copper, aluminum, cut glass, etc. It is used by the leading railways, automobile makers, power stations, etc., and is said to be very satisfactory in its results.

WHITEHEAD MACHINERY COMPANY has opened an office at 517 Park Building, Pittsburg, to care for its increasing eastern business. It will be in charge of Mr. Harry G. Adams, formerly with Wickes Bros., of Saginaw, who is thoroughly familiar with the second-hand machinery trade.

THE NATIONAL WIRE CORPORATION, New Haven, Conn., has issued a condensed catalogue of its products, with price lists, tables of wire, etc. This booklet contains a number of valuable tables and a lot of useful information about the wire business. Copies will be furnished free of charge to anyone interested.

THE CHICAGO FUSE WIRE & MANUFACTURING COMPANY reports that it is meeting with great success in the introduction of the "Union" line of outlet boxes for rectangular push button switches of different makes. These boxes are designed primarily for use in finished buildings, or what is known as "old work," and for this purpose they afford great economy, as a hole may be cut and the box inserted without breaking the plaster or woodwork any more than will be covered by the ordinary switch plate. These boxes are carried in stock at the company's stores in Chicago, New York and Buffalo.

GOLD CAR HEATING & LIGHTING COMPANY has moved its offices to the Whitehall Building, 17 Battery Place, New York City, in order to secure more room, so badly necessitated by the remarkable growth of its business in electric and other car heating and in car lighting. The Gold Company has moved its Chicago offices and concentrated them with the New York ones at the new address. The company has also made another important move by securing a contract from Mr. T. A. Edison, under which it has the exclusive sale in the United States of the Edison storage battery for train lighting purposes.

"THINKABLE THINKLETS" is the title of an interesting pamphlet just issued by the Warren Electric Manufacturing Company, Sandusky, Ohio. As the name implies, the contents give some things to think about concerning the Warren alternator, which is so well known. This machine is of the induction type, and its simplicity of construction is well brought out in this unique folder. A list is given of the users of this make of machine, and it is a very long one. The machine is thoroughly illustrated, each of the principal parts being shown up with much clearness. These "thinkable thinklets" should be well thought over by those interested in this line of apparatus, as much can be learned from them.

PHOENIX ENGINES.—One of the most artistically designed catalogues we have ever seen has come to us from the Phœnix Iron Works Company, Meadville, Pa., and while it is artistically and mechanically a model, practical value and utility have not been sacrificed. Utilitarianism and art can be combined in a catalogue as well as anything else requiring expert knowledge and experience in its production. So much for the artistic features of the catalogue. The business side has received as much care. The contents represent the latest and highest development of the Phœnix engine, which is so well known in electric power transmission and lighting enterprises. These engines are built in the simple, tandem-compound and cross-compound types, and are designed to withstand the most exacting service in the generation of electric energy. Each class is illustrated by a typical engine, and it is in the illustrations where the greater part of the artistic skill has been applied. Equally excellent illustrations give views of the most important details of the engines, and cross-section views show in an exceedingly clear manner the internal construction of the cylinders and the assembling and relation of the parts. These illustrations, besides being of great utility to the business man, have educational advantages in that the design and construction of the machines are so clearly displayed. In other words, they give a clear and true conception of the actual mechanism of the steam engine. The text explains briefly the constructional features of these well-known machines, and after a careful study of the contents of the catalogue one is left with a very good idea of the merits of these engines. There are three pages giving reproductions of indicator cars intended to illustrate the advantages resulting from the use of the Phœnix compound valve gear. Views are also given of direct-connected units, the catalogue closing with a set of tables showing dimensions, power ratings, etc., of the various classes of engines under consideration.

ACTON ENGINE ROOM SPECIALTIES.—John Acton, who is one of the well-known manufacturers of engine room and other specialties, has a 32-page catalogue, fully illustrated, giving details of a number of things he makes. Mr. Acton says he has now on his books orders for 12 months ahead. The factory at 118 John St., Brooklyn, N. Y., is running steadily, and the merit of his apparatus has caused him to be flooded with orders.

OTTO WEISS MACHINE DEPARTMENT of the Chase Machine Company, of Cleveland, Ohio, writes as follows through Mr. Thomas A. Aiton, manager: "We manufacture machinery used for forming electric wires and cables and for insulating the same. We manufacture a large range of these machines for all kinds of insulation from silk to lead. I worked from some four years in Berlin, Germany, as assistant to Mr. Otto Weiss, who was for many years the head engineer at Siemens Bros., London, and who manufactured and laid a great number of submarine cables. Later he established his own company in Berlin, for the manufacture of machines used in this line of work. Perhaps it would interest you to know that I have just placed a 4-head cabling machine with the Waclark Wire Company, at Bay Way, N. J. This machine is 96 feet long and weighs 55,000 pounds, and is used for making 61-wire strands up to two million circular mills. We have also placed several of these machines, as likewise similar ones, though smaller, in many of the wire and cable works of this country."

THE STERLING ELECTRIC COMPANY, Lafayette, Ind., reports an unusual business in its solid back long distance transmitters for toll lines, magneto exchanges and common battery exchanges.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MARCH 1, 1904.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., New York.]

753,252. TELEPHONE-REPEATER; Merritt Gally, Brooklyn, N. Y. App. filed March 18, 1903. (See page 525.)

753,258. ELECTRIC SWITCH; Gerald W. Hart, Hartford, Conn. App. filed Nov. 23, 1903. Means for insulating and mounting the current-carrying parts.

753,276. LAMP SOCKET AND PLUG; Daniel A. Kimbark, Chicago, Ill. App. filed May 21, 1902. A socket and plug designed especially for use on berth-lights; the invention being in the details of construction.

753,278. WINDING FOR ELECTRICAL MACHINES; Frederick J. Lindeman, Pittsburg, Pa. App. filed April 11, 1903. (See Current News and Notes.)

753,321. LAMP SOCKET; Duny A. Schutt, Peru, Ind. App. filed April 7, 1903. A holding device for the two-part cover consisting of a cross-bar embedded in the porcelain to which the shell and cap are secured.

753,345. AUTOMATIC RELEASING DEVICE FOR SAFETY TROLLEYS; Andrew C. Wolfe, Pittsburg, Pa. App. filed July 6, 1903. Details of construction.

753,356. BRUSH HOLDER; Charles O. Bulock, Milwaukee, Wis. App. filed Aug. 21, 1903. A coil-spring supplying the pressure upon the brush is adjustable in tension by engaging any one of its turns with a projection adapted to pass between them.

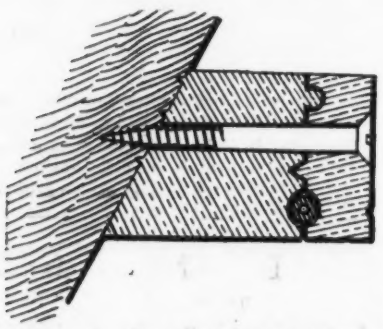
753,365. ELECTROMAGNETIC SIGNAL; William U. Colthar, Springfield, O. App. filed July 24, 1903. The semaphore is moved by causing a cylindrical armature to roll along a track, its rotary motion serving to raise or lower the signal.

753,383. PROCESS OF PREPARING ELECTRODES FOR STORAGE-BATTERY CELLS; Oskar Frank, Detroit, Mich. App. filed May 2, 1903. (See page 526.)

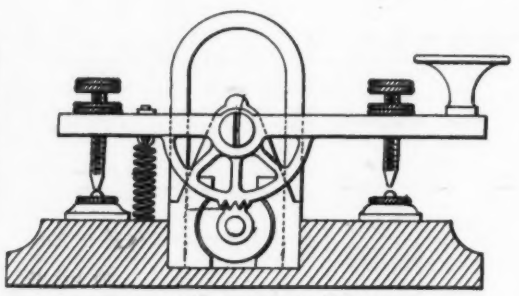
753,391. CASING FOR TELEPHONES OR MICROPHONES; Paul Hardengen, Berlin, Germany. App. filed Sept. 3, 1902. (See page 525.)

753,398. CLEAT FOR ELECTRIC WIRING; Emory C. Hunt, Belle Plaine, Ia. App. filed Nov. 8, 1902. An insulator having an inclined base for attachment to the wall.

753,399. COMBINATION BRACKET AND KNOB FOR ELECTRIC CONDUCTORS; Emory C. Hunt, Belle Plaine, Ia. App. filed Nov. 8, 1902.



753,398.—Cleat for Electric Wiring.



753,429.—Electrodynamic Generator.

An insulator knob is formed integrally with a bracket through which the supporting screw passes.

753,422. ARMATURE-WINDING; James F. McElroy, Albany, N. Y. App. filed Nov. 11, 1902. (See Current News and Notes.)

753,429. ELECTRODYNAMIC GENERATOR; George M. Pelton, Chagrin Falls, O. App. filed Sept. 29, 1902. The machine has two sets of commutator segments, each corresponding in number to the number of armature coils; the brushes engaging the commutators are so related that all of the coils may be connected in series or any number in parallel, or two independent circuits may be supplied therefrom.

753,434. RAIL JOINT; Benton C. Rowell, Chicago, Ill. App. filed April 9, 1903. Details.

753,461. ELECTRICAL CONDUCTOR AND COIL; James C. Anderson, Jersey City, N. J. App. filed April 30, 1903. The conductor is a ribbon wire covered with a straight envelope of paper, the edges of which are separated on one side of the ribbon; the turns of the coil are wound with the open side of the covering outward, so that the tension alone will retain the insulation in place in the completed coil.

753,466. DISINFECTING ATTACHMENT FOR TELEPHONES; Carlo Bravi-Bertini, Amboy, N. J. App. filed Sept. 16, 1903. (See page 525.)

753,493. TELEPHONE; Stephen C. Houghton, San Francisco, Cal. App. filed April 3, 1903. (See page 525.)

753,509. ELECTROTHERAPEUTIC DEVICE; Charles K. Munns, Corning, Ia. App. filed Oct. 24, 1903. A cabinet containing devices for generating currents for electrotherapeutic purposes, with switchboard and auxiliaries.

753,533. RHEOSTAT; John C. Barclay, New York, N. Y. App. filed Sept. 9, 1903. (See Current News and Notes.)

753,536. CONTACT DEVICE FOR ELECTRICALLY PROPELLED RAILWAYS; Henri Berthoud, Neuchatel, Switzerland. App. filed July 10, 1902. Each car carries on its roof a contact strip running the full length which overlaps the strip on the adjacent cars, the electrical terminals suspended above drag upon these conductors to deliver current to the vehicle.

753,542. TROLLEY; Alexander C. Calderwood, Gloversville, N. Y. App. filed Aug. 6, 1903. The trolley replacer is tripped and allowed to move into operative position when the wheel leaves the wire.

753,552. TROLLEY FOR ELECTRIC CARS; William A. Daggett, Vineland, N. J. App. filed Sept. 3, 1903. Details.

753,554. TROLLEY; Arthur S. Deem, Reading, Pa. App. filed Aug. 8, 1903. Two trolley wheels, one arranged behind the other and one being pivoted on a horizontal axis while the other is pivoted on a vertical axis.

753,556. ELECTRIC METER; Thomas Duncan, Lafayette, Ind. App. filed Dec. 29, 1903. The object is to provide a construction whereby parts of the rotating elements may be made saparable to enable the substitution of new parts without sending the meter to the factory.

753,562. JACK-FIELD FOR TELEPHONES; Lars Magnus Ericsson, Stockholm, Sweden. App. filed June 18, 1902. (See page 525.)

753,563. PORTABLE OR TABLE TELEPHONE INSTRUMENT; Lars Magnus Ericsson, Stockholm, Sweden. App. filed Sept. 30, 1902. (See page 525.)

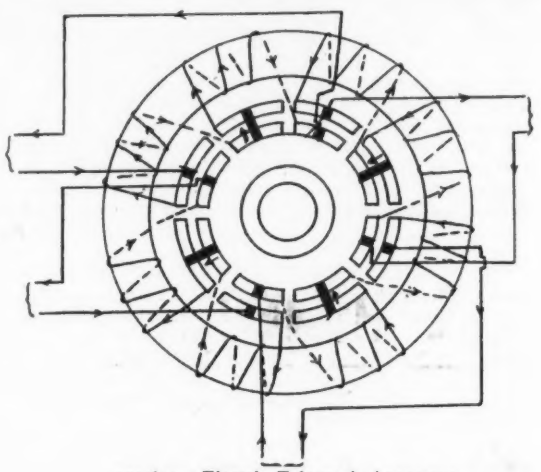
753,582. LIGHTNING ARRESTER; Harold N. Keifer, Topeka, Kan. App. filed June 30, 1903. A part of the circuit is wound in grooves on an insulating cylinder, and a flat plate is held against the face of the cylinder within striking distance of the turns thereon, the plate being grounded.

753,595. INSULATED PIPE JOINT; Waldo A. Learned, Watertown, Mass. App. filed Sept. 8, 1903. Details.

753,617. TROLLEY REPLACER; Francis A. Nolan, St. Paul, Minn. App. filed Jan. 16, 1902. Details.

753,666. RAILWAY SIGNAL; Tony Bruck, New York, N. Y. App. filed Jan. 26, 1903. The moving cars strike cam-shaped levers pivoted in the road bed to control the circuits of the signaling system.

753,690. ELECTRIC TELEGRAPH APPARATUS; Agacio Falcone, Florence, Italy. App. filed May 6, 1903. A Morse transmitting key oscillates the armature of a magneto, which at each movement sends an impulse to line.



753,690.—Electric Telegraph Apparatus.

753,704. AUTOMATIC MAGNETIC CIRCUIT BREAKER; Frank O. Hartman, Mansfield, O. App. filed April 10, 1902. Details of an oil-switch.

753,714. CONDUIT FOR ELECTRICAL CONDUCTORS; Hubert Krantz, New York, N. Y. App. filed Sept. 9, 1903. A metallic conduit having sides terminating in inwardly turned shelves, forming a constricted opening through which the wire may be temporarily passed and held by the shelves until a cover is applied.

753,716. CARBON RESISTANCE AND METHOD OF PRODUCING AND ADJUSTING SAME; George I. Leonard, Pasadena, Cal. App. filed Feb. 3, 1903. (See page 526.)

753,757. SELF-WINDING ELECTRIC CLOCK; Frank T. Talcott and Benjamin F. Kerr, Ashtabula, O. App. filed March 11, 1903. Details of a clock in which the pendulum is actuated by the attraction and repulsion of electro-magnets.

753,759. ELECTRICAL CONNECTION; Edward G. Thomas, Cambridge, Mass. App. filed July 15, 1902. For soldering terminals of rail-bonds to the under face of the rail, said terminals have spout-shaped extensions into which the melted solder is poured and by which it is conveyed to the abutting surfaces of the bond and rail.

753,809. AUTOMATIC PLAYING APPARATUS FOR MUSICAL INSTRUMENTS; Timothy B. Powers and Major R. Jewell, New York, N. Y. App. filed Aug. 14, 1901. Various devices for controlling the resistances in circuit with the magnets which operate the keys so that all the variations and combinations of tone, expression, etc., indicated by a composer can be obtained.

753,819. ELECTRODE; George Jones Atkins, Tottenham, England. App. filed April 8, 1903. (See page 526.)

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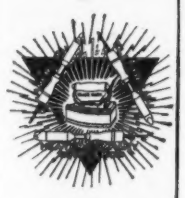

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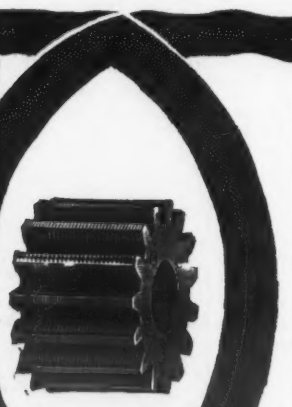

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POSITION WANTED.—By a really first-class engineer and superintendent of electrical properties; A-1 references and ability; parties desiring a capable man with wide experience and executive ability should reply. Address No. 1346, care Electrical World and Engineer, New York.

POSITION WANTED.—As manager or superintendent; fourteen years' practical experience installing and operating light and power plants, water power and steam. Address No. 1282, care Electrical World and Engineer, New York.

POSITION WANTED.—By graduate of the International Correspondence Schools with an electric manufacturing company or either in a power house or a railway station; height 6 ft., weight 170 lbs., age 20 years. Address No. 1359, care Electrical World and Engineer, New York.

POSITION WANTED.—Young electrician (32) having twelve years' practical experience and good technical training, desires position in isolated (preferred) power, light, etc., plant. Address No. 1357, care Electrical World and Engineer, New York.

POSITION WANTED.—By mechanical and electrical engineer in charge of design and construction of large light and power or street railway layouts; successful past experience in charge of large and heavy work; results and economy. Address No. 1352, care Electrical World and Engineer, New York.

POSITION WANTED.—As assistant in electric light and power plant in the Western States by electrical engineer, 26 years old; 4 years' practical experience and 4 years in University in Germany. Address No. 1354, care Electrical World and Engineer, New York.

POSITION WANTED.—Young man desires to learn electrical business; willing to work and would be satisfied to start at small pay. Address No. 1356, care Electrical World and Engineer, New York.

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POSITION WANTED.—Electric Light Manager now occupying responsible position in large western city would consider similar opening in eastern United States or Canada. Address No. 1345, care Electrical World and Engineer, New York.

POSITION WANTED.—As foreman in meter department of lighting company by a technical graduate with four years' factory experience in testing, inspecting T. H. Westinghouse watt-hour meters, G. E. and Sprague motors and generators; A-1 record with above companies. Address No. 1361, care Electrical World and Engineer, New York.

POSITION WANTED.—As superintendent of electric light plant by man 32 years of age, married; have had ten years' experience as superintendent of direct and alternating-current stations; have had present position four years; can leave here about May 1. Address B. S. Lincart, Lebanon, Ky.

POSITION WANTED.—With general manager of electric light company; experience gained in the commercial division of largest public utility corporation in the country; thoroughly conversant with the most modern and up-to-date methods in use in the consumers', contract, claim, lamp and municipal departments; also familiar with the operating departments; can furnish best of references; possesses invaluable information for company requiring rejuvenation. Address No. 1353, care Electrical World and Engineer, New York.

POSITION WANTED.—City sales manager of large New York supply house for past 3 years is at liberty; would like to represent manufacturer in this market; can furnish best references both as to ability and character. Address No. 1349, care Electrical World and Engineer, New York.

POSITION WANTED.—By manager of railway and lighting system; engaged in present situation four years; desires change as manager or general superintendent; fourteen years' practical engineering and business experience; for details and references, address No. 1362, care Electrical World and Engineer, New York.

POSITION WANTED.—Engineer, thoroughly experienced in all branches of construction work and repairs, particularly as applied to electric railways, desires position; power station erection and equipment a specialty; accustomed to take charge of work; eleven years' experience in America and abroad. Address No. 1364, care Electrical World and Engineer, New York.

(*Continued on page 45.*)

ALTERNATING GENERATORS.

60 CYCLES.

1100 or 2200 volts, 7200 Alternations.

	Lt.		Speed.
2	300	Gen. Elec., 15-K.W., comp., single phase, with exciter	720
1	500	Wood, 25-K.W., comp., iron clad armt., single phase, with exciter	720
1	600	West., 30-K.W., comp., toothed iron clad armt., single ph., with exciter	825
1	750	Wood, 37½-K.W., comp, iron clad, armt., single phase, with exciter	525
1	900	West., 45-K.W., comp., toothed armt., 2 phase, 1100 v., with exciter	720
1	1200	West., 60-K.W., toothed armt., single ph., comp., with exciter	720
1	1500	Warren-Medberry, 75-K.W., 2 ph., ind. type, with exciter, 2200 v.	600
1	1500	Stan., inductor, 75-K.W., 2 phase, 1100 or 2200 v., with exciter	900
1	1500	West., 75-K.W., comp., distributed winding, 2 ph., 1100 v., with exciter	900
2	1500	West., 75-K.W., 2 ph., 2200 v., d. c. to 14x14 Gates 4-valve aut., engine, complete with exciter	300
1	1500	Wood, 75-K.W., comp., slotted armt., with exciter	600
1	2400	Gen. Elec. 120-K.W., 3 phase, 2200 or 3300 v., with exciter	600

125-133 CYCLES ALTERNATING GENERATORS.

	Lt.		Speed.
1	630	Wood, 33-K.W., comp.,	1680
1	750	West., 37½-K.W.	1650
1	750	Wood, 37½-K.W., comp.	400
1	900	Warren-Medberry, 45-K.W., inductor type	1380
1	1000	Wood, 50-K.W., comp.	1400
2	120	West., 60-K.W., toothed armt., comp.	1650
1	1500	Wood, 75-K.W., comp.	1050
1	1500	Stanley, inductor type, 75-K.W., 1100 or 2200 v., 2 phase	
1	1800	West., 90-K.W., comp., toothed armt.	1500
1	2400	Gen. Elec., 120-K.W., type A 120, latest type, comp., toothed armt	1070
2	2400	Gen. Elec., 120-K.W., type A S, comp., slotted armt.	1070

LATEST TYPES OF (second-hand) ELECTRICAL MACHINERY

FOR SALE AT BARGAIN PRICES

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing complete list of apparatus with NET PRICES. All machines fully guaranteed.

	Lt.		Speed.
2	2400	West., 120-K.W., comp., self-oiler, toothed armt.	1375
1	4000	Stan., inductor type, 200-K.W., 1100 or 2200 v., 2 phase	670
1	8000	West., 400-K.W., slotted armt., 3 bearings, distributed windings	445

110 TO 125 VOLT GENERATORS.

DIRECT CURRENT.

	Lt.		Speed.
4	10	West. Elec., M. P.	1350
1	25	Triumph, M. P., comp.	1400
1	35	Crocker-Wheeler	1200
3	40	Gen. Elec., type I B	1900
1	45	Excelsior, M. P.	900
3	45	West., M. P., comp.	1800
1	45	Gen. Elec., type C E	2050
1	50	Crocker-Wheeler	1150
1	50	C. & C., comp., self-oiler	1550
1	50	Northern, M. P.	2100
3	55	Edison, self-oiler, 3-K.W.	1900
2	60	Hobart, M.P., comp., s-o.	1200
1	75	Hobart, M.P., comp.	1300
2	75	West., M. P., comp.	1650
1	80	Riker, M. P., comp., s-o.	1100
1	80	New Eng., multipolar	1450
1	80	Perrett, multipolar	950
2	80	Card, multipolar	1250
1	80	Crocker-Wheeler, comp.	1350
1	100	Card, M. P.	1000
2	100	Hobart, M. P., comp.	1500
2	100	Northern, M.P., comp.	1600
2	100	Com., M. P., comp.	1350
1	150	Eddy, M. P.	1650
1	120	West. Elec., M.P., comp.	750
1	180	Triumph, M.P., comp.	1200
1	210	Triumph, M.P., comp.	1100
1	210	Eddy, M. P.	1100
1	210	Sprague-Lundell, M. P.,	1050

	Lt.		Speed.
1	210	Crocker-Wheeler, M. P.	1000
2	210	Edison, s-o., 12-K.W.	1500
1	250	Fuller, M. P., comp.	580
1	300	Perrett, M. P., comp.	750
1	300	Phoenix, M. P.	1100
1	300	Ahlms-Edwards, M. P.	825
2	350	Edison, 20-K.W., comp.	1400
2	350	C. & C., M.P., 20-K.W.	800
1	350	Card, M.P., comp.	800
1	400	Crocker-Wheeler, M. P.	1150
1	400	Triumph, M. P., comp.	950
1	400	Crocker-Wheeler, M. P.	875
1	400	Northern, 22½-K.W.	1000
2	450	Edison, 25-K.W., s-o.	1300
1	450	Gen. Elec., M. P., comp.	1100
1	450	Sprague-Lundell, M. P.	925
1	540	C. & C., M.P., 30-K.W.	700
1	540	Fisher, M.P., comp.	
2	540	Gen. Elec., M.P., comp.	1000
3	600	Card, M.P., comp.	850
2	700	Commercial, M. P., comp.	865
1	750	Card, M. P., comp.	750
2	800	Edison, 45-K.W., comp.	1000
1	900	Wagner, M. P., comp.	950
2	1000	Edison, s-o., 60-K.W.	700
1	1300	Walker, M. P., 75-K.W.	600
1	1300	Card, M. P., comp.	500
1	1800	Edison, 100-K.W., s-o.	650

DIRECT CONNECTED UNITS

	Lt.		Speed.
1	100	G. E., 6 pole, comp., d.c. to 12x13 Weston aut. engine, 60-K.W., 125 v.	375
1	1350	Waddel-Entz, 80-K.W., d. c. to Ball engine, 15x14, 125 v.	265
1	1350	Ft. Wayne, comp. d. c. to 13x14 Buckeye vert. engine, 80-K.W., 125 v.	275
2	130	Gen. Elec., M. P., 6 pole shunt, d. c. to Ames tandem comp. 11x17x12 aut. engine, 12 v.	278
1	2500	West. Elec., M.P., comp. for d.c., brand new, 150-K.W., 125 v.	240

	K.W.		Speed.
1	40	Commercial, M.P., d.c. to 11x12 aut. Chandler-Taylar engine, 250 v.	300
1	75	Siemens & Halske, Churchward type, M.P., brand new, for d. c., 250 v.	300
2	75	West., 60 cycle, 2 phase, 2200 v., d. c. to 14x14 Gates 4-valve aut. engine, complete with exciter	300

220 TO 250 VOLT GENERATORS.

	K.W.		Speed.
1	12	Crocker-Wheeler, M. P.	1000
1	12	Card, M. P., comp.	800
1	12	Westinghouse, M. P.	1400
1	15	Edison, self-oiler	1400
1	20	Western Electric	150
1	20	Edison, self-oiler, comp.	1400
1	20	Wagner, multipolar	1200
1	20	Keystone, M. P., comp.	950
1	20	Eddy, M. P., comp.	950
1	20	Diehl, M. P., comp.	925
1	25	Crescent, multipolar	1000
1	25	Commercial, s-o, comp.	1380
1	30	Western Elec., M. P.	600
1	30	Triumph, M. P., comp.	950
1	37½	Keystone, M. P., comp.	800
1	40	C. & C., M. P., comp.	750
1	40	Crocker-Wheeler,	950
1	40	Eddy, M. P., comp.	850
1	40	Keystone, M. P., comp.	900
1	45	Am. Engine C., M. P.	750
2	45	Edison, comp., self-oiler	1000
1	45	Gen. Elec., M. P., comp.	925
1	59	Eddy, M. P., comp.	850
1	50	Triumph, M. P., comp.	900
1	55	Fuller multipolar, comp.	750
1	70	Western Electric, comp.	585
1	75	C. & C., M. P., comp.	525
1	80	C. & C., comp., self-oiler	625
1	100	Edison, comp., self-oiler	650
1	100	Commercial, M. P., comp.	750
2	220	Eddy, M. P., comp.	700
1	125	Thompson-Ryan, M. P.	375
1	125	Siemens & Halske, M. P.	
2	150	National, M. P., comp.	350
1	200	Eddy, M. P., comp.	500
1	300	Western Elec., M. P.	480

500 TO 550 VOLT GENERATORS.

	K.W.		Speed.
1	60	Edison, comp., self-oiler, new armt. and commutator	700
1	62	T.-H., D 62, s-o., comp.	900

DYNAMOS ✱ MONEY SAVERS ✱ ENGINES

500 VOLT GENERATORS AND MOTORS

2—500-K.W. Westinghouse, 4 pole.
3—300-K.W. General Electric, 4 pole.
1—300-K.W. Westinghouse, 6 pole.
1—200-K.W. General Electric, 4 pole.
1—200-K.W. Edison bipolar.
2—175-K.W. Edison bipolar.
1—150-K.W. Westinghouse, 4 pole.
1—110-K.W. General Electric, 6 pole.
2—100-K.W. General Electric, 4 pole.
2—100-K.W. Edison bipolar.
1— 75-KW. Westinghouse, 6 pole.
4— 75-K.W. General Electric, 4 pole.
3—D-62-K.W. T. H. bipolar.
Complete stock of motors.

220 VOLT GENERATORS AND MOTORS

1—120-K.W. C. & C., 6 pole.
1—100-K.W. C. & C., 6 pole.
1— 50-K.W. Bullock, 4 pole.
1— 40-K.W. Crocker-Wheeler, 4 pole.
1— 16-K.W. Ft. Wayne, 4 pole.
1— 12-K.W. Keystone, 4 pole.
Complete stock of motors.

110-125 VOLT GENERATORS AND MOTORS

2—45-K.W. Westinghouse, 4 pole.
2—60-K.W. Edison bipolar.
1—40-K.W. C. & C., 4 pole.
1—35-K.W. Loomis, 6 pole.
1—35-K.W. Mather, 4 pole.
1—21-K.W. Riker, 4 pole.
1—17½-K.W. General Electric, 4 pole.
1—15-K.W. Edison bipolar.
1—12½-K.W. Card, 4 pole.
2—3-K.W. Westinghouse bipolar.
Complete stock of motors.

DIRECT CONNECTED UNITS

200-K.W. Thomson-Ryan, 125 volts, D. C. McEwen Tandem Engine.
80-K.W. Jenney, 125 volt, D. C. Russell 4-valve engine.
50-K.W. Northern, 125 volt, D. C. Russell (new).
2—50-K.W. American Ball, 220 volts, D. C. duplex and simple engines.
2—42-K.W. Westinghouse D. C. Alfrey engines.
30-K.W. Eddy, 125 volts. D. C. Watertown engine.
25-K.W. Westinghouse, 125 volt, D. C. Westinghouse.
7½-K.W. Northern, 125 volt, D. C. Hill Vertical Engine (new).
6-K.W. ditto.
4-K.W. ditto.
3-K.W. ditto.

ALTERNATING (60 Cycle

250-K.W. Westinghouse, 60 cy., 2 ph., 2,200 volts.
100-K.W. G. E., 60 cy., 3 ph., 2,300 v.
65-K.W. Stanley, 60 cy., 2 ph.
20-H.P. Westinghouse, 2 ph., 60 cy.
3-H.P. Westinghouse, 2 ph., 60 cy.
2-H.P. G. E., 3 ph., 60 cycle.

ALTERNATING (125 Cycle)

120-K.W. G. E., s. ph., 1,100 v.
120-K.W. Westinghouse, 2,200 v.
100-K.W. G. E., s. ph., monocyclic.
2—A-70 T. H., s. ph., 1,100 v.
1—60-K.W G. E., s. ph., 1,100 v.
2—35-K.W. Westinghouse, 1,100 v.
10-H.P. Excelsior, s. ph., 125 cycle.

ENGINES

3—11 and 17x24 Harrisburg tandem.
1—16 and 30x48 Hamilton Corliss.
1—17x42 Brown of Fitchburg.
1—14x28 Delamater Corliss.
1—13x21 Buckeye tangye bed (130 H.P.).
1—13x14 McIntosh & Seymour.
2—13x12 Erie Ball automatic (with subbases).
2—9½x10½ McIntosh & Seymour.
1—8x8 Climax automatic.

Boilers **THOMPSON SON & CO., 114 LIBERTY ST., N. Y.** Equipments

MODERN ELECTRICAL MACHINERY FOR SALE.

DIRECT CONNECTED UNIT, 220 volts

50-K.W. American Ball Dynamo & Engine.

10 VOLTS DIRECT CURRENT
Dynamos or Motors

30-K.W. Bullock, M. P.
15-K.W. Eddy, M. P.
10-K.W. Eddy, M. P.
5-K.W. C. & C.
3-K.W. C. & C.
2-K.W. Lundell.
1-K.W. C. & C.

500 VOLTS DIRECT CURRENT
Dynamos or Motors

15-H.P. General Elec., M. P.
7½-H.P. General Elec., M. P.
5-H.P. Sprague.
2-H.P. General Elec.

220 VOLTS DIRECT DURRENT
Dynamos or Motors

40-H.P. Sprague, M. P.
25-H.P. Crocker-Wheeler, M. P.
20-H.P. Card.
15-H.P. Sprague, M. P.
10-H.P. General Elec.
10-H.P. Holtzer Cabot.
7½-H.P. Card.
7½-H.P. Edison.
7½-H.P. C. & C.
5-H.P. Paragon, M. P.
5-H.P. Holtzer Cabot.
5-H.P. Crocker-Wheeler.
3-H.P. Diehl.
3-H.P. C. & C.
2-H.P. General Elec.
2-H.P. Diehl.
1½-H.P. C. & C.
1-H.P. Crocker-Wheeler.

ALTERNATING INDUCTION MOTORS

2 Phase, 60 Cycles, 220 Volts

30-H.P. Type F Westinghouse.
15-H.P. Type C Westinghouse.
10-H.P. Type C Westinghouse.
7½-H.P. Type C Westinghouse.
5-H.P. Type C Westinghouse.
2-H.P. General Elec.
1-H.P. Westinghouse.
½-H.P. General Elec., 220 or 110 v.
¼-H.P. General Elec.

2 Phase, 440 Volts, 60 Cycles

30-H.P. Westinghouse.
15-H.P. Westinghouse.
10-H.P. Westinghouse.
7½-H.P. Westinghouse.
5-H.P. Westinghouse.
3-H.P. Westinghouse.
1-H.P. Westinghouse.

3 Phase, 60 Cycles

5-H.P. Westinghouse, 220 volts.
2-H.P. Gen. Elec., 110 volts.
2-H.P. Westinghouse, 220 volts.
½-H.P. General Elec., 220 volts.
½-H.P. General Elec., 110 volts.

1 Phase, 60 Cycles

7-H.P. Wagner, latest type.
½-H.P. General Elec.
¼-H.P. General Elec.

1 Phase, 125 Cycles

3-H.P. Wagner, latest type.
1-H.P. General Elec.
½-H.P. Emerson.
1/10-H.P. Emerson.
Large stock of small motors, autostarters, starting boxes, rheostats, switchboards, voltmeters, ammeters, etc.

I BUY, RENT AND INSTALL.—GEORGE BENDER, 137 CENTRE STREET, NEW YORK.

BARGAINS IN (second-hand) ELECTRICAL MACHINERY

We do not offer old, worn out machines fit for the Junk pile, but the LATEST TYPES of the leading manufacturers.

GREGORY ELECTRIC CO.
54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing NET prices—all machines fully guaranteed.

	K.W.		Speed.
1	75	Akron, M. P., 6 pole	900
2	75	Bullock, multipolar	900
2	75	Gen. Elec. M. P., 4, comp.	700
1	100	Edison, comp.	650
1	100	Siemens & Halske, M. P.	600
3	100	Gen. Elec., M. P., 4, comp.	650
1	100	Westinghouse, M. P., 6	650
1	120	Westinghouse, M. P.	625
1	200	Gen. Elec., M. P., 4, comp., s-o., three bearings	400
1	200	Thompson-Ryan, M. P.	525

ARC DYNAMOS.

	Lt.	C.P.		Speed.
1	35	2000	T.-H., L D 2 ball	820
1	45	1200	Brush, No. 7.	1050
1	50	1200	T.-H., L D 12, new ball	820
2	50	2000	T.-H., M D 2, s-o., ring	820
1	65	2000	Brush, No. 8	950
1	75	1200	T.-H., M D 12, s-o,	820
1	75	1200	Wood	950
1	100	2000	Wood	600
1	125	1200	Brush, 6.6 amp.	700
2	125	2000	Brush, 9.6 amp.	500
1	125	1200	Excelsior	700

220 TO 250 VOLT MOTORS.

DIRECT CURRENT.

	H.P.		Speed.
1	1	Crocker-Wheeler, self-oiler	900
1	1	Commercial, self-oiler	1200
1	1	Paragon, self-oiler	1100
1	2	Edison, self-oiler	1600
1	2½	Gibbs, multipolar	1250
1	3	Gibbs, M. P.	1400
1	3	Westinghouse, M. P.	1700
1	3½	Paragon, self-oiler	1000
1	5	Western Electric, M. P.	950
3	5	Gibbs, M. P.	1400
1	7½	Western Electric, M. P.	975
1	7½	Towle, M. P.	1050
1	7½	Commercial, M. P.	1300
1	7½	Gen. Elec., M.P., form H	800
1	10	Sprague-Lundell, M. P.	1175
1	10	Keystone, M. P.	1175
1	10	Lundell, M. P.	1060
1	15	Crocker-Wheeler, M. P.	810
1	15	Card, M. P.	700
1	15	Westinghouse, M. P.	1200
1	18	Edison, 15-K.W.	1150
1	25	Western Electric	525
1	25	Keystone, M. P.	725
1	25	Eddy, M. P.	725
1	25	Diehl, M. P.	750
1	30	Crescent, M. P.	800
1	40	Western Electric, M. P.	400
1	40	Keystone, M. P.	700
1	40	Triumph, M. P.	750
1	45	Crocker-Wheeler, M. P.	850
1	50	C. & C., M. P.	560
1	50	Eddy, M. P.	675
1	50	Keystone, M. P.	750
2	60	Edison, self-oiler	75
1	60	General Electric, M. P.	700
1	65	Triumph, M. P.	700
1	65	Eddy, M. P.	650
1	70	Fuller, multipolar	600
1	75	Sprague, self-oiler	500
1	85	Western Electric	500
1	100	C. & C., M.P., 6 pole	450
1	100	C. & C., self-oiler	450
1	125	Edison, self-oiler	550
1	135	Commercial, M. P.	675
2	150	Eddy, M. P.	600
2	200	National, M. P.	300

500 TO 550 VOLT MOTORS.

	H.P.		Speed.
1	1	Crocker-Wheeler	1200
1	1	Diehl, self-oiler	1875
1	1	New England	1100
2	1½	Crocker-Wheeler	1550
2	2	C. & C., self-oilers	1350
1	2	New England, self-oiler	1200
1	2	Crocker-Wheeler	1100
1	2	Lundell	940
2	3	Gen. Elec., type C E	1800
2	3	Crocker-Wheeler	1100
1	3½	Roth, self-oiler, M. P.	950
1	4	Triumph, M. P.	1250
1	4	Perrett, multipolar	725
1	5	Northern, M. P.	1180
1	5	Amer. Engine Co., M. P.	1550
1	5	Westinghouse, M. P.	1500
3	5	Crocker-Wheeler	950
1	7½	Northern, M. P.	1500
1	7½	Crocker-Wheeler	1500
1	7½	General Electric, M. P.	1600
1	10	Perrett, M. P.	600
1	10	Northern, M. P.	1350
1	10	Triumph, M. P.	1100
1	10	Crocker-Wheeler	1275
1	10	General Electric, M. P.	1400
1	15	Kester, M. P.	1250
1	15	C. & C., self-oiler	975
1	15	Perrett, M. P.	1100
1	18	T.-H., D 15, self-oiler	1550
1	20	Kester	1400
1	20	S. & H., M. P., Churchward	900
1	20	Perrett, M. P.	700
1	20	Commercial, M. P.	900
1	25	New England, multipolar	900
1	25	Card, multipolar	500
1	35	Card, M. P., self-oiler	775
1	40	Wood, multipolar	750

ALTERNATING CURRENT MOTORS.

SINGLE PHASE. 125-133 CYCLES.

	H.P.		Speed.
1	½	Wagner, 104 v., aut.	2000
1	1	Fort Wayne, 104 volts	2500
1	1	Wagner, 208 volts, aut.	2000
2	1½	Wagner, 208 volts, aut.	2000
1	5	Wagner, 104 volts, aut.	2000
1	½	Phillips, 104 volts	1800
1	½	Holtzer-Cabot, 104 volts	2500
1	½	Emerson, 104 volts	2000
1	½	Stanley, 104 volts	2000
1	½	Wagner, 104 volts, aut.	2000
1	1	Fort Wayne, 104 volts	2500
1	1	Wagner, 208 volts, aut.	2000
1	1½	Wagner, 208 volts, aut.	2000
1	5	Wagner, 104 volts, aut.	2000

SINGLE PHASE. 60 CYCLES.

	H.P.		Speed.
2	½	Phillips, 104 volts	1800
1	½	Phillips, 208 volts	1800
3	½	Phillips, 104 volts	1800
3	½	Phillips, 208 volts	1800
1	1	Phillips, 208 volts	1600
1	1	Phillips, 104 volts	1600
3	1	Wagner, 208 volts	1800
1	3	Wagner, 208 volts	1800
1	7½	Wagner, 104 volts	1800
1	15	Wagner, 104 volts, aut.	1200
2	30	Wagner, 104 volts, aut.	1200

THREE PHASE. 125-133 CYCLES.

	H.P.		Speed.
1	3	General Electric, 110 volts	1875

TWO PHASE. 60 CYCLE.

	H.P.		Speed.
1	1	West., type C, 110 v.	1800
1	1	West., type C, 200 v.	1700
1	2	Gen. Elec., 220 v.	1800
1	3	Stanley, 500 v., with condenser	1860
1	7½	West., type B, 400 v.	1200
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(Continued from page 42.)

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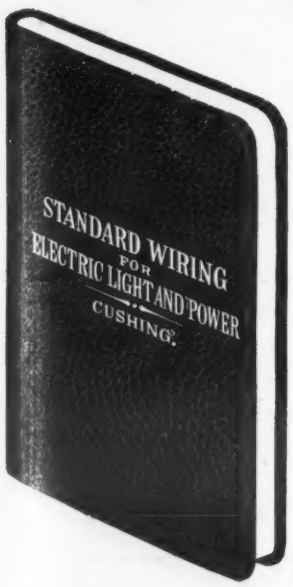

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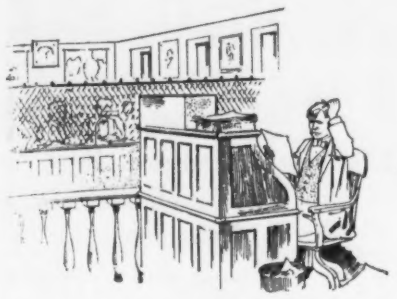

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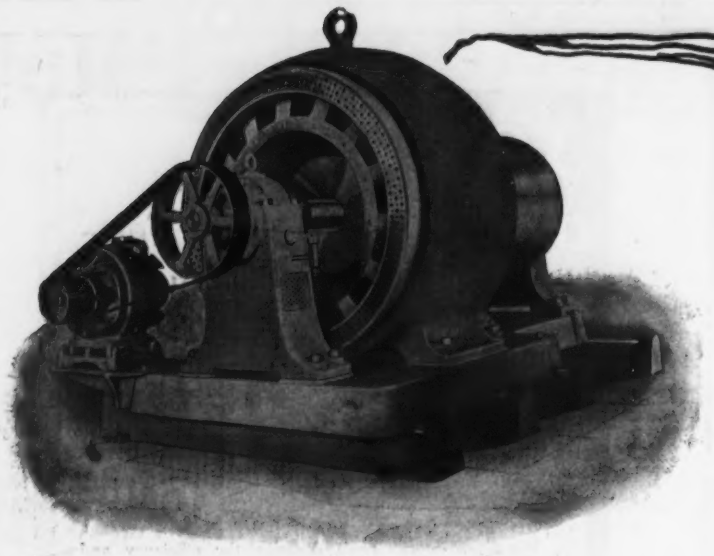

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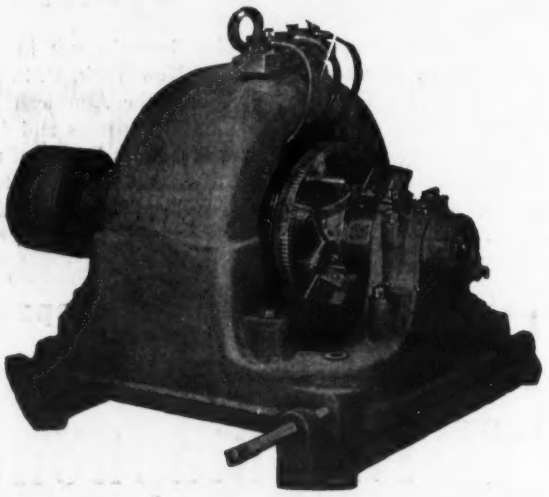

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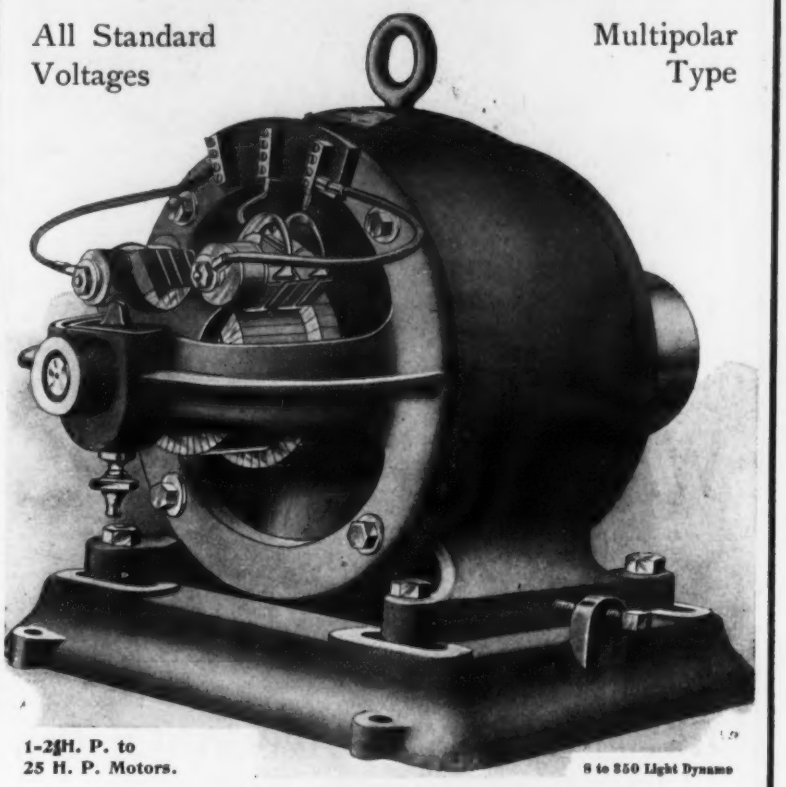

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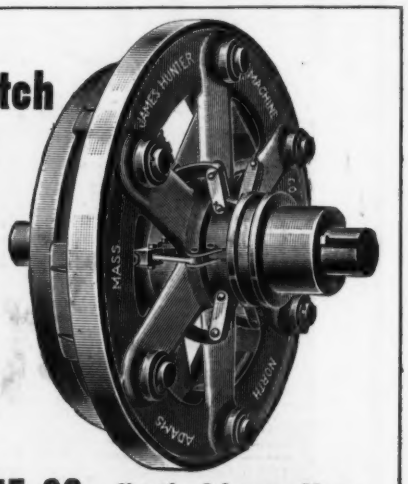

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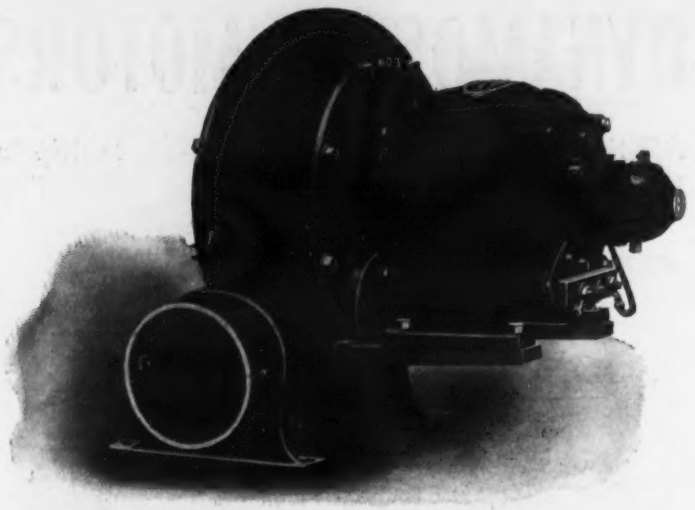

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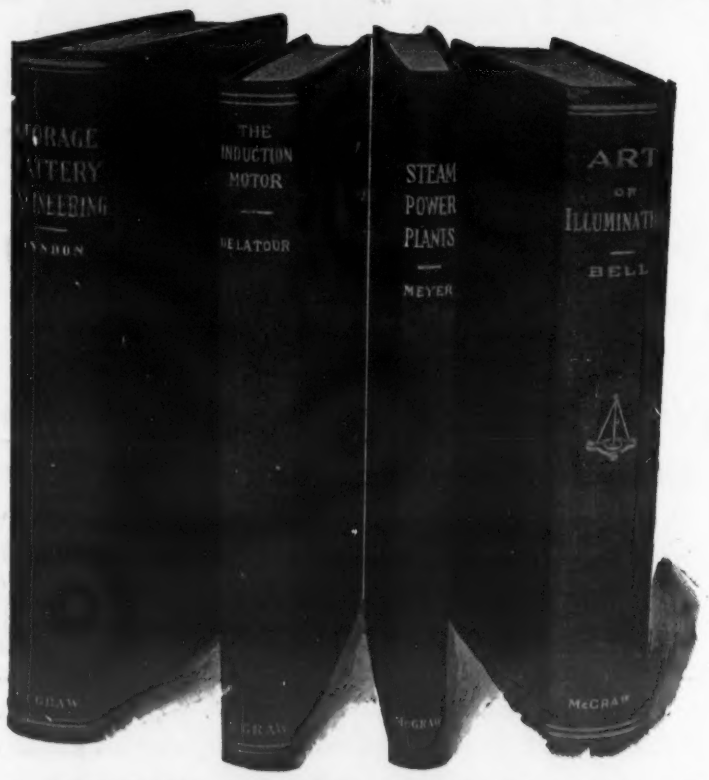

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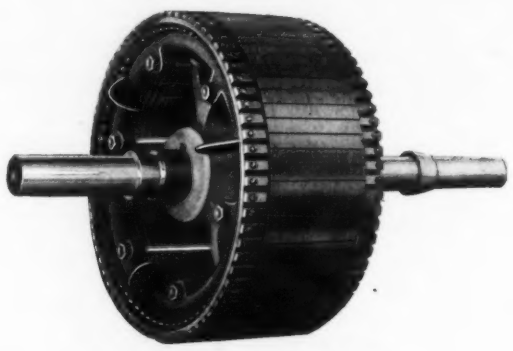

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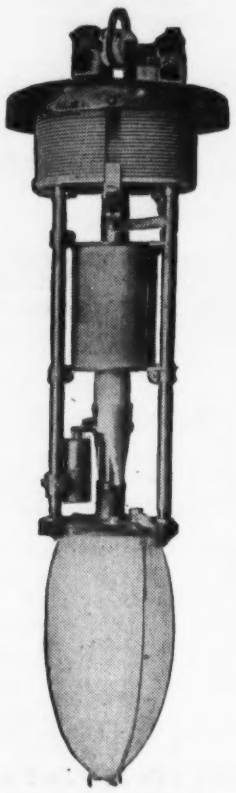

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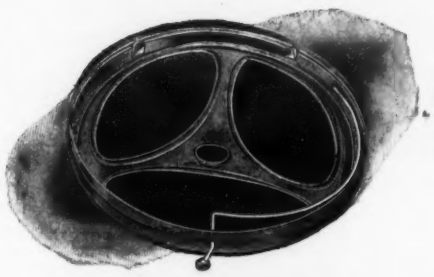

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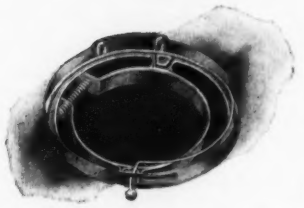

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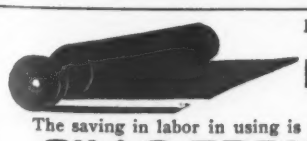

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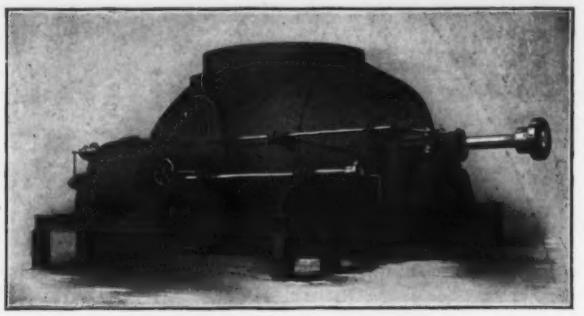

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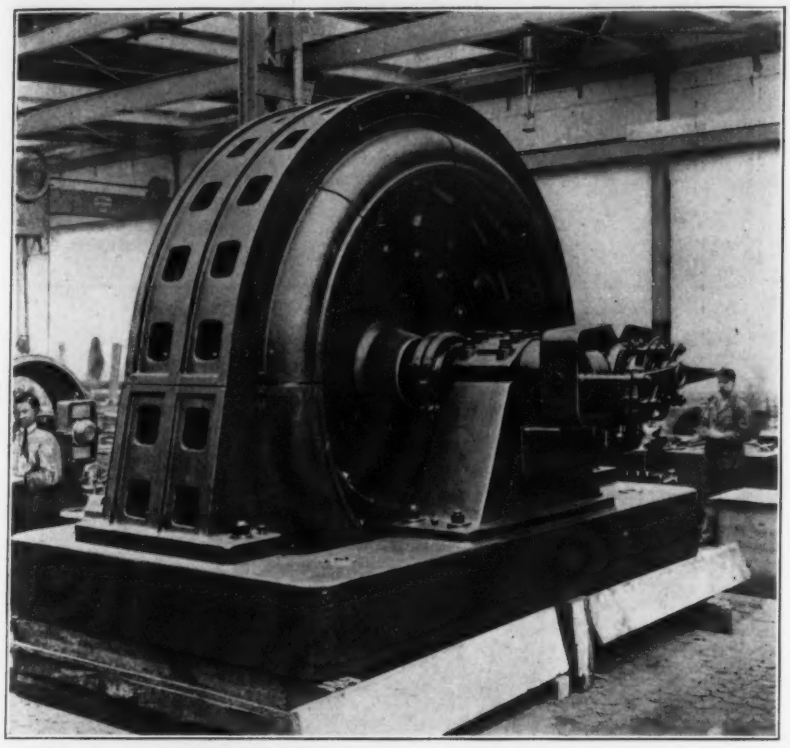

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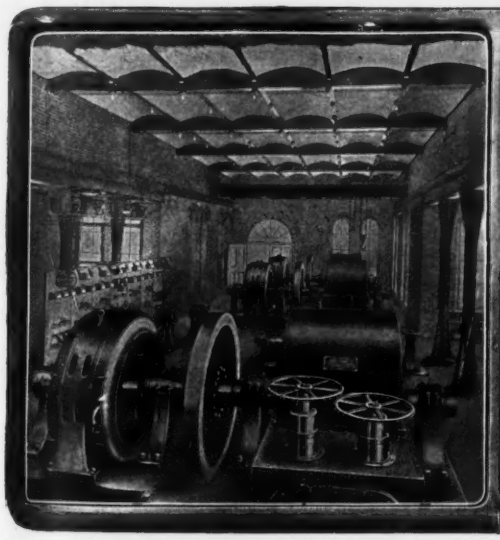

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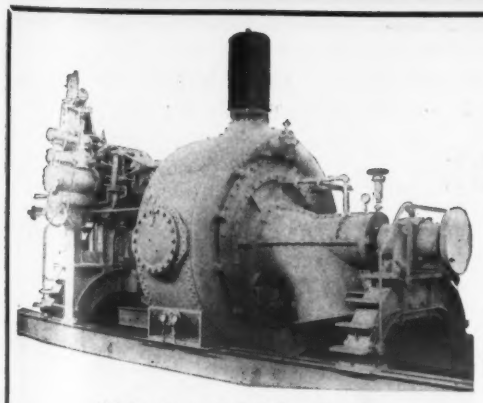

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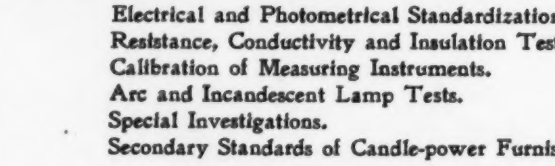
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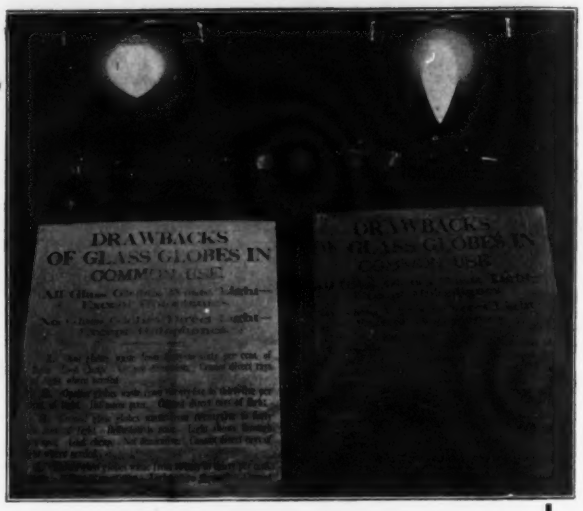

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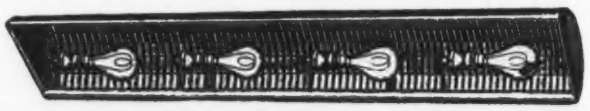

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